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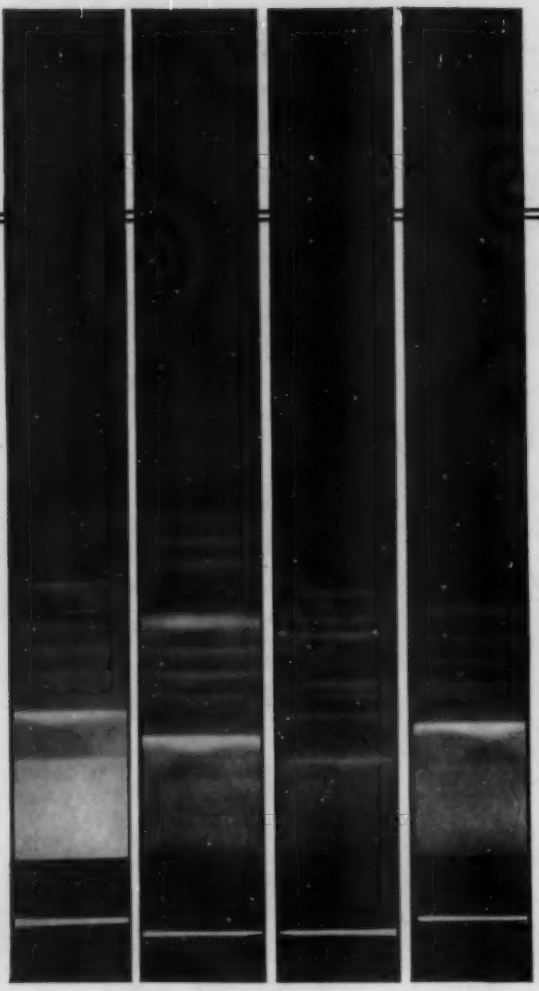

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VOL. 42 DECEMBER, 1939 No. 6

CONTENTS

Prepyloric Ulcer and Carcinoma. . . . . D. A. SAMPSON, M.D., AND M. C. SOSMAN, M.D. 797

A Clinical Study of the Reactions following Employment of Pitressin in Cholecystography . B. R. KIRKLIN, M.D., AND E. E. SEEDORF, M.D. 811

The Reticulo-endothelial Neoplasia . . . . . RALSTON PATERSON AND MARGARET C. TOD 820

Metastatic Pulmonary Infiltrations of Inflammatory Origin . . . . . ALFRED J. ACKERMANN, M.D. 828

Metastases from Carcinoma of the Tongue. MAURICE D. SACHS, M.D. 833

Spontaneous Amputation of the Tongue . . SAMUEL RICHMAN, M.D. 843

Roentgen Pelvimetry; A Simplified Method . . . . . E. G. REUTER, M.D., AND R. J. REEVES, M.D. 847

The Present Status of Roentgen Treatment of Sinus Infections . . . . . W. B. FIROR, M.D., AND C. A. WATERS, M.D. 857

Deep Roentgen-Ray Therapy of Mammary Carcinoma. III. Fifteen Year Results in a Formerly Published Group and a Statistical Analysis of 1,200 Cases Treated between 1922 and 1937. . . . . W. A. EVANS, M.D., AND T. LEUCUTIA, M.D. 866

Fracture of the Neck of the Femur Complicating Roentgen Therapy of Ovarian Cancer . CLARA L. OKRAINETZ, M.D., AND S. B. BILLER, M.D. 883

Radium Therapy in Hodgkin's Disease . CARLOS SAYAGO, M.D. 888

Malignant Tumors of the Tongue . VON DOLLINGER DA GRAÇA, M.D. 890

Vascularization of the Brown-Pearce Rabbit Epithelioma Transplant as Seen in the Transparent Ear Chamber . . . . . A. G. IDE, M.D., N. H. BAKER, M.D., AND S. L. WARREN, M.D. 891

Radium Quantity Meter . . . . . ROBERT B. TAFT, M.D. 900

The Midwinter Conference of Eastern Radiologists J. F. ELWARD, M.D. 903

Editorials

The Radiotherapeutic Aspect of Malignant Tumors of the Thyroid Gland 909

David Ralph Bowen, 1872–1939 912

Society Proceedings, Correspondence and News Items 915

Department of Technique

An Apparatus for Stereoscopic Roentgenography of the Skull . . . . . PAUL C. HODGES, M.D. 921

Electrical Protective Devices in Radium Work . JACK DE MENT 930

Abstracts of Roentgen and Radium Literature 934

Subject Index to Volume 42. 937

Author Index to Volume 42. 948

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

VOL. 42 DECEMBER, 1939 No. 6

PREPYLORIC ULCER AND CARCINOMA*

By D. A. SAMPSON, M.D., *and* M. C. SOSMAN, M.D.

BOSTON, MASSACHUSETTS

ALTHOUGH little has been written concerning the comparative frequency of benign ulcer and carcinoma in the prepyloric region considerable argument has taken place. Hampton[6] contended that benign ulceration in this region is of such infrequent occurrence that all prepyloric ulcers should be considered malignant until proved otherwise not only by complete serial sectioning but also by a long-time follow up. He reviewed the literature and made an analysis of cases seen at the Massachusetts General Hospital, finding carcinoma to outnumber benign ulcer by 12 to 1. On the other hand, Singleton[13] stated that he found benign prepyloric ulcer to be twice as frequent as the malignant variety in the cases which he saw at the Toronto General Hospital.

In attempting to study this problem several difficulties are immediately encountered. Chief among these is that of the actual meaning of the term "prepyloric." In common usage by roentgenologists, surgeons and pathologists it is rather loosely applied to that vaguely defined portion of the stomach fairly close to the pyloric sphincter; to some, all lesions distal to the incisura angularis fall within this designation while others restrict them to the distal centimeter or so immediately adjacent to the ring. Hampton has defined this region as being limited to exactly 1 inch proximal to and excluding the ring, stating that often in the fresh specimen a definite transition is noted in the mucosa at the beginning of this area and that it has differences in physiological activity and response to disease when compared with the remainder of the stomach. Singleton used the same definition.† Unfortunately for the purposes of this study, this limitation of the term has not been generally adopted. We have found lesions reported as being "in the prepyloric region," "along the pylorus" or "in the pylorus," regardless of whether they were actually restricted to the ring or situated anywhere distal to the incisura angularis. Hampton has specified that for an ulcer to be truly prepyloric its center must be not more than 2.5 cm. from the ring. Here again we run into difficulties. In a large percentage of cases coming to operation the actual size and site of the ulcer has not been specified, the surgeon sometimes being content with the statement that "a large ulcer was

† Pathologists make use of the presence of Brunner's glands in distinguishing the duodenum from the prepyloric area. In a recent case seen at the Massachusetts General Hospital the pathologist, on examining a freshly removed specimen, agreed that the ulcer was prepyloric, that it was 2 cm. proximal to the pyloric ring. Yet microscopic examination showed Brunner's glands present underneath the ulcer so that it was finally classified as "pyloric." Apparently there is individual anatomic variation; thus this means of differentiation is not entirely reliable.

* From the Department of Roentgenology, Peter Bent Brigham Hospital, Boston, Mass. Presented before the New England Roentgen Ray Society, February 18, 1938.

found on the posterior wall near the lesser curvature." Such inadequacy of description automatically makes such cases valueless for study purposes and because roentgen films are periodically destroyed, because pathological specimens are rarely saved for more than a few months and photographs of specimens are difficult to interpret, one cannot learn the exact site of the lesion. An unavoidable difficulty in comparing the frequency of benign ulcers and carcinomata in a given region arises because of the fact that while the former are usually relatively small and definitely circumscribed the latter very frequently are so large that it is impossible to determine definitely the exact original site of involvement. Very few carcinomata are limited to the prepyloric region as defined above, whether with or without ulceration.

Our study is based on a series of 545 cases admitted to the Peter Bent Brigham Hospital, comprising all those cases of gastric ulcer and gastric carcinoma subjected to operation or autopsy during the twenty-five year period from the opening of the hospital in 1913 to the end of 1937. In classifying lesions as prepyloric we have adhered to Hampton's definition. Some cases not strictly in this category are cited because on account of the common loose usage of the term "prepyloric" they are relevant to this discussion. However, lesions actually on the pyloric ring are not classified as prepyloric and should not be considered as such.

In the roentgen diagnosis of the nature of lesions in the distal portion of the stomach the interpretation ranges from the clear cut definite carcinomata, through those of more or less obscure nature, to those which appear to be benign ulcer. A definite diagnosis of carcinoma is practically never in error but as will be shown by the cases here reported the chance of error in the other groups may be great.

Difficulty is encountered when there is obstruction in the neighborhood of the pyloric sphincter. Because of the resultant large gastric residue, the barium is greatly diluted preventing satisfactory study of the mucosa; visualization is so unsatisfactory that a definite diagnosis usually cannot be made at the first examination. In the face of such pyloric obstruction, which can be produced both by malignant infiltration and by the scarring of long standing, benign inflammatory changes in the prepyloric region as well as by stenosis of the sphincter itself and by scarring from duodenal ulcer, the proper procedure is to wash out the stomach and have the patient come to the roentgenoscopic room with an aspiration tube in the stomach. In this way the roentgenologist can be sure that the stomach is free from retained contents before commencing his examination. This will frequently result in obtaining the correct diagnosis without untoward delay.

REPORT OF CASES

CASE 1. B. L. (M45903), male, aged fifty-four, began in December, 1933, to have crampy abdominal pain after meals which was relieved by taking alkaline powders. In March, 1934, roentgenologic studies elsewhere were interpreted as indicating gastric ulcer and he was put on a Sippy diet with improvement. However, toward the end of the year his symptoms became worse and he began to have vomiting, sometimes with coffee-ground material.

On coming to this hospital in December, 1934, he had lost 45 pounds but the physical examination was essentially negative. *Free acid was 74, total acid 86;* the aspirated stomach contents gave a four plus benzidine reaction. Roentgen examination showed a trace of barium remaining at the end of six hours. There was constant rigidity and irregularity in the region of the pylorus and the ring could not be definitely identified. By roentgenoscopy this irregularity was thought to be in the duodenal cap but on the films it appeared to be prepyloric and therefore suggestive of carcinoma (Fig. 1). On re-examination nine days later the rigid irregular area in the pyloric region was much the same. It was impossible to be certain whether the pylorus was proximal or distal to the lesion. The appearance was interpreted as suggesting a perforated ulcer with perigastric adhesions but in view of the possibility of prepyloric carcinoma exploration was advised.

At operation the pyloric region was found firmly bound up to the region of the common bile duct and portal vein; immediately at the pylorus there was a deeply puckered and scarred area anteriorly. The margins of this extended into the stomach where one could palpate great induration or actual tumor growth but no tumor came through to the serosa. The external appearance was that of cancer but no obviously involved glands were seen so a resection was done with a Billroth No. 2 anastomosis.

Pathological examination showed a large ulcer crater which almost completely encircled the lower 2 cm. of the stomach and upper 1 cm. of the duodenum with edges raised and projecting. Except for a small perforated area at the lower end of the ulcer the floor was about 1 cm. in thickness and very firm. Microscopic diagnosis: carcinoma of the pylorus with metastases to the regional lymph nodes.

Death occurred eleven days after operation.

This case presented features characteristic of ulceration. Rigidity, however, suggested carcinoma. One sometimes detects a palpable mass corresponding to the site of the lesion, with or without rigidity; this may be of help in establishing that the lesion is malignant.

Case 11. J. O. (S44593), previously reported by Patterson and Gross.[10] This patient, a male, aged twenty-seven, was admitted in June, 1933, because of three attacks of epigastric pain and vomiting which had occurred during the preceding six months. These attacks had been precipitated by indulgence in alcoholic beverages and had subsided with milk diet and bismuth powders. There had been a loss in weight of 25 pounds.

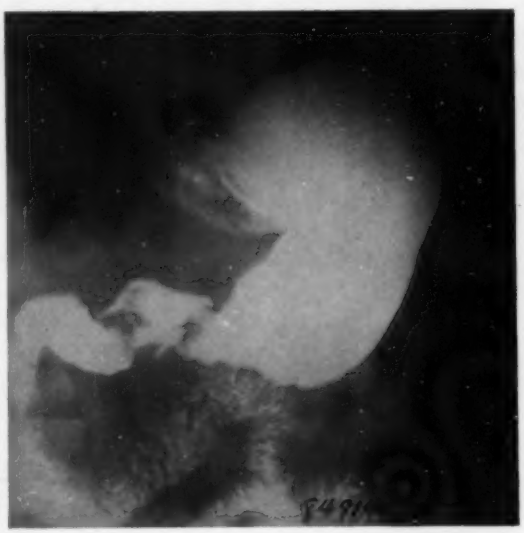

Fig. 1. Case 1. (X84914) Note the irregularity in the prepyloric region. Exact location of pylorus difficult to determine.

Fig. 2. Case 11. (X78434) Note the thickening and irregularity of the rugae in the distal portion of the stomach, and crater in prepyloric area.

Physical examination was negative, except for evidence of weight loss. *Free acid was 60, total acid 100.* Roentgen examination showed the rugae in the prepyloric area to be thickened with an irregularity of the wall at this site. At six hours there was a 5 per cent residue. The duodenal cap appeared normal. These studies suggested a prepyloric ulcer (Fig. 2).

On a Sippy regimen the patient rapidly became symptom free and he had regained 15 pounds when he was re-examined at the end of ten weeks. Again there was found irregularity extending up from the pyloric sphincter about 5 cm. along the lesser curvature. At the incisura angularis there was a definite filling defect with a central crater, and no peristalsis passed through this zone; the rugae were enlarged; no residue was present at six hours. The findings now suggested neoplasm rather than ulcer but

FIG. 3. Case III. (X91152) Note the transverse rugae puckered toward the crater, erroneously said to be indicative of benignancy.

the physical examination was essentially unchanged.

At operation September 23, 1933, a mass about 7.5 cm. in diameter was found along the lesser curvature extending up from the pylorus. The stomach was quite mobile and no metastases were found so a resection was done with a Horsley modification of the Billroth No. 1 anastomosis. Pathological examination confirmed the diagnosis of adenocarcinoma. The tumor measured 3.5×4.5 cm. on the mucosal surface and contained an ulcer crater 3×3.5 cm. in size, 1.2 cm. in depth.

Subsequent progress was satisfactory until August, 1936, when symptoms appeared indicating metastasis to the liver and probably to the spine. Death occurred in March, 1937, three and one-half years after operation.

In this case it will be noted that the original "prepyloric ulcer" was not within Hampton's inch; we have included this instance, however, because of the common usage of the term. Several important features are illustrated. Age and acidity are of no value in ruling out malignant disease—this patient was a young man of less than thirty years and acidity was high; the facts here were not marked exceptions to the general run of cases. Bloomfield[2] has shown that carcinoma may be present without anacidity. Similarly, response to diet in the form of symptomatic improvement is misleading; persistence of the lesion as shown by roentgen examination is more important and the progress with time clarifies the diagnosis.

CASE III. H. M. (S53801). In November, 1936, a man, aged sixty-four, came to the outpatient department complaining of epigastric pain radiating through to the back. Of two months' duration, it was not periodic but usually came on after meals and was relieved occasionally by soda. Roentgen examination showed vigorous peristalsis but a 10 per cent residue was present at six hours. There was definite puckering of the rugae just prepyloric in location with a small crater on the lesser curvature; the duodenal cap was normal. Interpretation: gastritis and a small gastric ulcer (Fig. 3).

He was put on a Sippy diet and seemed quite comfortable. At re-examination three weeks later the mucosa in the prepyloric region was again found to be puckered; the small crater in the pyloric canal appeared smaller than previously. There was still a 10 per cent residue. Interpretation: pyloric ulcer (Fig. 4).

The patient continued to remain well until late in December when the pain became worse in spite of the use of powders and rigid adher-

FIG. 4. Case III. Condition three weeks after Figure 3. Note decrease in the size of the ulcer crater.

ence to the diet. Roentgen examination January 3, 1937 (nine weeks after the first examination) showed the crater now definitely larger, measuring 11 mm. in diameter, and there was a smooth constant concavity on the lesser curvature of the antrum. The stomach was more dilated and atonic with a large six hour residue. The duodenal cap was asymmetrical at the base but otherwise normal (Fig. 5). The findings were still interpreted as suggesting a benign ulcer rather than carcinoma but because of the obstruction excision was recommended; it was thought that the condition might be due to subacute perforation.

On admission to the hospital at this time, with a weight loss of 16 pounds in three months, physical examination was essentially negative; there was no abdominal tenderness and no palpable mass. *Free acid was 10, total acid 50.* At operation a small hard mass the size of the end of a finger was found on the posterior surface of the pyloric area with a hard area in addition in the pancreas. No involved glands were encountered. A resection was done including 1½ inches of the duodenum and the distal third of the stomach with a Billroth No. 2 anastomosis. Pathological examination showed an area of ulceration "along the pylorus in the region of the lesser curvature." The ulcer was 2 cm. in length and 1 cm. in depth and was surrounded by an area in which the gastric wall was indurated; the remainder of the gastric mucosa was fairly normal in appearance. Microscopic diagnosis: adenocarcinoma of the stomach.

Subsequently the patient continued to have epigastric distress and burning. In April, 1938, he was having much right upper quadrant pain but no evidence of recurrence could be demonstrated by roentgen examination.*

The above case showed a small ulcer within the prepyloric segment as defined by Hampton. Roentgenologically it presented no feature to indicate malignancy at the first examination; the second showed apparent improvement and even at the third, carcinoma could not be diagnosed. This case is typical of many and it is in this group that the most frequent, and to the patients, most costly errors occur. We could cite numerous other instances with the same sequence of events, many of them with the ultimate operation at such a late date that not even palliative procedures could be performed by the surgeon.

* This patient died of metastases Jan. 26, 1939.

Fig. 5. Case III. Six weeks after Figure 4; crater definitely larger; large six hour residue observed.

Case IV. A. P. B. (S40312), male, aged thirty-five, in the winter of 1929–1930 began to have epigastric pain and discomfort, a dull gnawing with belching two to three hours after meals relieved by food and soda. In the summer of 1930 a roentgen diagnosis of peptic ulcer was made elsewhere. He was put on a bland diet with powders and remained symptom free for one year.

In the summer of 1931 the patient began to have epigastric fullness and voluminous belching of gas. Roentgen examination here in November showed the stomach atonic with 75 per cent residue at six hours. The antrum was smoothly pointed but no barium could be forced through the pylorus. Interpretation: an obstructive lesion at the pylorus, probably ulcer. The patient was taught to aspirate the retained contents of the stomach; this with powders controlled the symptoms.

In September, 1931, he had begun to have pain on motion in the left hip; this became increasingly more severe necessitating the use of a cane for walking and finally keeping him at home. On December 13, he aspirated the stomach as usual but found the fluid of a coffee-ground character; 1,500 cc. of this fluid was obtained so the patient was immediately admitted

to hospital. Physical examination was negative except for pallor and slight tenderness in the left epigastrium. The vomitus showed no free acid, had a total acidity of 24; the test for occult blood was strongly positive and the stool reacted similarly.

Because of the pain in the hip roentgenograms were made. These showed mottled irregular areas of destruction in places and regeneration of bone in and around the involved areas. The appearance was similar to that seen in metastatic malignancy of slowly growing type but hyperparathyroidism was considered as well. The skull was normal. The second and third cervical vertebrae showed condensation and some defects; the thoracic vertebrae showed some osteoplastic changes. The ribs, scapulae and humeri were of the same character; the lungs showed an extensive coarse mottling and the findings were interpreted as due to extensive miliary metastases, source unknown. Examination of the stomach showed a residue of 50 per cent at six hours. Again there was marked obstruction at the pylorus, apparently due to irregular contraction of the duodenal cap rather than to a lesion on the gastric side although it was difficult to locate the pylorus exactly. There was a constant crater just beyond the point of narrowing suggesting the crater of a duodenal ulcer.

Blood studies showed calcium 10, phosphorus 3.5, phosphatase 1.6. It was considered that the value for phosphatase indicated rapid bone destruction, interpreted as pointing to Paget's disease rather than to carcinoma.

Early in January, 1932, operation was performed. The pyloric end of the stomach, the pylorus and the first portion of the duodenum presented a hard massive tumor about the size of an English walnut, fixed to the head of the pancreas. The ampulla and the neck of the gallbladder were adherent to it and it was obvious that all this tissue showed an infiltration and induration due to an extensive disease process. A chain of glands was present along the upper border of the pancreas, not as hard as those usually seen in carcinoma but frozen section established this diagnosis. Posterior gastroenterostomy was done to relieve the pyloric obstruction.

The immediate result was satisfactory and the symptoms were relieved. Death occurred, however, three months later. Autopsy showed a hard annular mass without ulceration at the junction of the stomach and duodenum, 2 to 3 cm. in diameter; it stopped short at the duodenum. The microscopic diagnosis was scirrhous carcinoma of the pylorus. There were metastases to the skeleton, heart, lungs, right adrenal, the regional lymph nodes and over the surface of the small intestine.

This case illustrates the fact that a malignant lesion at or just proximal to the pyloric sphincter can produce a picture indistinguishable from that of duodenal ulcer. It will be noted that some degree of obstruction was present, putting the roentgenologist at a disadvantage. We might conclude, therefore, that in the presence of such obstruction, unless there is definite knowledge of the presence of a duodenal ulcer for many years, carcinoma should be suspected.

Surgical emergencies include perforated peptic ulcers and the site of ulceration is of interest. If the surgeon should report the perforation to be in the prepyloric region two questions immediately present themselves. In the first place, since good surgery no longer provides a pathological specimen by gastric resection (at the time of immediate operation, at least) are we justified in accepting his statement that it is prepyloric, particularly if there has been a previous roentgen diagnosis of duodenal ulcer? In the second place, assuming that he has been correct in his statement as to the location of the ulcer, can we accept his opinion that malignant disease is not present? Our records show that some credence at least can be given to his word, even in the absence of or contrary to previous roentgen evidence.

CASE V. W. A. O. (S40623), male, aged thirty-five, was admitted in December, 1931. For seven years he had suffered from epigastric pain coming on one hour after meals, relieved by soda or food and occasionally associated with nausea and vomiting. The pain would occur periodically and improvement would follow dietary restrictions. Physical examination on entry showed evidence of weight loss but was otherwise negative. *Free acid was 0, the total acid was 20* and the benzidine reaction of the stomach contents was strongly positive; after histamine there was still no free acid. Roentgen

examination December 14 showed a constant projection from the lesser curvature at the incisura 12 mm. wide and 10 mm. deep with a crater on palpation. There was also slight irregularity of the greater curvature at the pylorus with some narrowing of the antrum. At six hours there was a 25 per cent residue. Interpretation: gastric ulcer (Fig. 6). Re-examination January 6 showed only a very minute crater where the large ulcer had previously been observed but the irregularity and narrowing of the antrum were still present, unchanged or

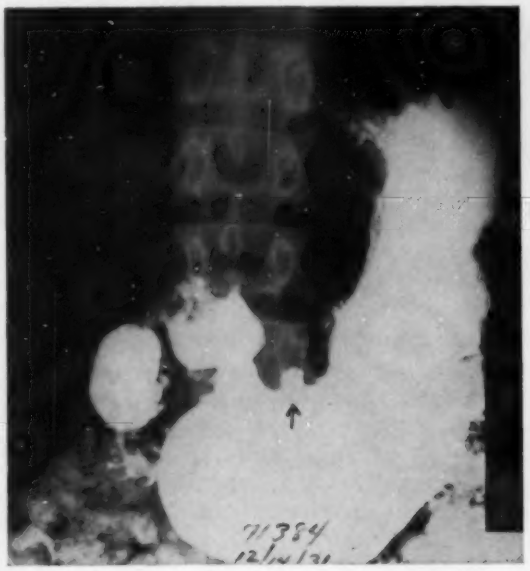

Fig. 6. Case v. (X71384) Note projecting crater 1 cm. in diameter which appears characteristic of benign ulcer.

slightly more marked. There was a 20 per cent residue. Interpretation: healing gastric ulcer; indefinite pyloric lesion with retention (Fig. 7).

On diet there was symptomatic improvement; the pain disappeared but no weight was regained. While still symptom free a check up examination was done February 18 and the stomach was found to be more atonic than previously with a residue of 80 per cent. The irregularity and narrowing of the antrum had increased and except for slight flexibility the appearance now suggested an annular carcinoma. The gastric ulcer had entirely disappeared. As previously the duodenum was quite normal. Interpretation: obstructive lesion of the pylorus, probably carcinoma or lymphoma (Fig. 8).

Operation was performed immediately. At first sight the region of the pylorus appeared

Fig. 7. Case v. Three weeks after Figure 6, patient on medical treatment. Crater barely visible.

normal but there was found on the greater curvature at the site of the lesion as demonstrated by the roentgen studies a mass of great blood vessels almost like an angioma and beneath this

Fig. 8. Case v. Two months after Figure 7. Irregular filling defect involving distal 2 cm. of stomach, strongly suggesting carcinoma; this was due to to spasm.

mass the wall of the stomach was slightly thickened. At the pylorus itself one could feel the usual thickening of the muscle but the presence of an ulcer could not be established. In view of the peculiar history it seemed advisable to excise the pylorus and part of the antrum; the excision was made just distal to the pylorus and for 6 cm. proximal. Pathological study showed that at the pyloric end of the lesser curvature there was a raised reddened oval area 2 cm. wide from which the folds of the mucosa radiated in all directions. In the central part of this area were two pinpoint-sized depressions surrounded by an indurated area 1×1.5 cm. The wall at this point was moderately thickened but elsewhere was of normal thickness. Microscopic diagnosis: healed gastric ulcer, no evidence of carcinoma. A lymph node excised was also negative for carcinoma.

Subsequently this man has been perfectly well. When last seen in April, 1938, six years after operation, he was free from symptoms and working; roentgen examination was entirely negative. The apparent filling defect (Fig. 8) was largely due to spasm and antral gastritis.

The above case is cited to illustrate that ulceration in the prepyloric region can be free from malignancy. It will be noted also that there was no free acid in the gastric contents even after histamine yet no carcinoma, again showing that study of the gastric acidity cannot be accepted as a reliable criterion in differentiating benign and malignant ulcerations.

In some cases the benign or malignant nature of a prepyloric ulcer may never be determined. The refusal of a patient to submit to operation with subsequent lack of follow up leaves us in doubt as to the true state of affairs. Just as puzzling is the following case:

CASE VI. L. A. P. (S27162). This man first came to the Peter Bent Brigham Hospital in April, 1922, at the age of fifty-three. Five years previously at the Boston Dispensary a diagnosis of gastric ulcer had been made; the abdominal pain associated with this cleared up without treatment. During the year before coming here he had recurrence of the pain which was dull and burning, and in addition vomiting. Roentgen studies at the Dispensary showed a pyloric ulcer; operation was advised but refused. Subsequently his symptoms became worse and he lost weight.

On being referred here he was emaciated but physical examination was otherwise negative. *Free acid was 18, total acid 30.* Roentgen examination showed an area of irregularity on the lesser curvature just proximal to the pyloric sphincter. (The size of this area was not stated and the films have been destroyed.) Tenderness was present in the region of the sphincter but the duodenum was normal. Interpretation: a lesion involving the lesser curvature in the region of the sphincter. Operation was performed a few days later disclosing induration involving the lesser curvature of the pyloric antrum and its posterior wall. To the surgeon this had the appearance of transition from chronic peptic ulcer to malignant disease; no metastases were seen. The antrum was resected. Pathological examination showed an ulcer just proximal to the pylorus on the posterior surface near the lesser curvature. The ulcer was indurated, was 1×2 cm. in size and 0.7 cm. in depth; one edge appeared firmer than the others. Microscopic diagnosis: gastric ulcer. The patient did well afterwards and never had any return of gastrointestinal symptoms.

In September, 1926, four and one-half years later, he was readmitted with signs of an intracranial tumor, was operated on and the tumor found. The pathological report was, "metastatic carcinoma, most likely of gastric origin." Suspecting the "gastric ulcer" as the source of the metastasis, the only remaining section was restudied but it showed only simple ulceration; the original specimen had been discarded so no more sections could be cut. According to the records "the microscopic examination of the ulcer appears to have been incomplete." No other source of a primary focus could be found in spite of thorough investigation. The patient died at home in October, 1926, with lung metastasis according to his physician; no autopsy was obtained.

When a patient who undergoes operation is found to have a benign prepyloric ulcer and subsequently develops metastases, what is one to conclude?

CASE VII. J. T. S. (S19500), male, aged thirty, was admitted in August, 1923. Four years previously he began to have epigastric discomfort, typical of duodenal ulcer, a gnawing constant pain relieved by food. During the second

two years he lost considerable weight and strength. Roentgen examination showed almost complete obstruction at the pylorus where there was definite constriction with a small round projection suggesting the crater of an ulcer. Interpretation: pyloric ulcer. Operation revealed that just proximal to the pylorus there was an indurated area on the superior aspect of the antrum with the omentum adherent to an old perforated crater. Pyloric resection was done with a Billroth No. 2 anastomosis. Pathological examination showed the ulcer to be 1 cm. in diameter and 0.7 cm. deep. Pathological diagnosis: pyloric ulcer. The operative result was satisfactory and the patient returned to his work as a plumber. Except for slight transient nausea after breakfast his digestion remained good and he had no other symptoms.

About 1930 there began to be pain in the left epigastrium radiating around to the back and both shoulders. There would be some relief with soda but none with milk or food; nausea and vomiting were usually present with the pain which occurred as a rule during meals. The attacks became more frequent and in February, 1935, more severe. One month later the patient noticed a mass in the left epigastrium, later spit up some blood and had black stools. When he came back into the hospital in May, 1935, there had been only slight loss of weight. Physical examination confirmed the presence of the mass; it was the size of an egg, tender and not hard. Roentgen studies revealed a large carcinoma in the region of the anastomosis so a resection was again done. Pathological examination showed the stoma partly occluded by the tumor which was 5 cm. in diameter. Pathological diagnosis: carcinoma of the stomach with metastases to the regional lymph nodes.

In August, 1937, there was roentgen evidence of recurrence of the carcinoma in the remaining portion of the stomach. When last seen in December he was declining rapidly.

The question arises as to the possible relation of the carcinoma to the ulcerated region removed so many years before. Was the original ulcer really a carcinomatous ulcer? The pathologist has expressed the opinion that these were two independent lesions.

From Table 1 it will be seen that while benign prepyloric ulcers do occur they are much less frequent in number (in cases coming to operation or autopsy) than malignant lesions. It will be noted also in the cases cited that many of the malignant ulcerations were erroneously diagnosed roentgenologically as benign. Are there actually any criteria by which the roentgenologist can accurately distinguish between these two types of ulceration?

TABLE I

ANALYSIS OF 545 CASES ACCORDING TO SITE AND TYPE OF LESION

Site of lesion	Carcinoma	Ulcer
Prepyloric inch	46	11
"Near pylorus" "Just proximal"	5	19
	51	30
Prepyloric region and antrum both involved	145	0
	196	30
Antrum involved without prepyloric region	43	32
	239	62
At pylorus	15	17
	254	79
Pars media	66	53
Cardia	38	3
Diffuse	38	0
Location questionable	7	7
	403	142

Kirklin and Weber[8] commenting on their roentgen similarity remarked that malignant ulcers carry no obvious marks of their nature. In their experience, however, the following points had been helpful in some cases:

Benign ulcer	*Malignant ulcer*
Niche dense	Niche often faintly depicted
Niche semicircular with a round margin	Margin and profile irregular
Accentuated and converging rugae	Situated where rugae effaced
Spasm present	Little if any spasm
Active peristalsis	Sluggish peristalsis
Tender	Rarely tender

However, they pointed out that these features are not infallible and that most errors result from considering ulcers benign in the absence of definite evidence of malignancy.

Singleton,[13 14] reporting benign ulcer outnumbering carcinoma by 2 to 4 times in his series, has contended that there are distinctive features by which it is usually possible to differentiate the two either at the first examination or at re-examination two or three weeks later at which time in the case of the benign ulcer the reflex spasm will be less and the crater smaller. Points in favor of benign ulcer as opposed to the malignant variety in his opinion are: presence of spasm out of proportion to the size of the ulcer although large ulcers have less spasm than the smaller ones; crater square or conical rather than deep with overhanging or heaped up margins; convergence of rugae towards the lesion; normal or hyperactive peristalsis, often associated with hypomotility although pyloric obstruction is practically always ultimately produced by the malignant ulcer with resultant hypomotility; absence of a palpable mass. He added, however, that ulcerating carcinomata have been known to show apparent improvement with medical treatment and stated that even after the disappearance of the ulcer the patient must be followed and re-examined.

Alvarez and MacCarty,[1] discussing ulcer and carcinoma of the stomach as a whole, pointed out that the size of the ulcer may be of definite assistance in differentiating the malignant from the non-malignant lesion. They found 92 per cent of benign ulcers anywhere in the stomach to be less than 2.4 cm. in diameter. While 23 per cent of carcinomatous ulcers were small enough to fall within this limit those ulcers larger than this were almost always malignant. Our experience bears out their contention; in the 11 cases of benign ulceration in the prepyloric inch which we encountered 9 were 1.5 cm. or less in diameter and the other 2 were less than 2.5 cm. in diameter. However, many of the malignant ulcers also fell into this size group. Thus, we consider that in prepyloric ulcerative lesions large size may be of definite value in establishing a diagnosis of carcinoma but small size does not help in ruling it out.

Convergence of the rugae towards the lesion, mentioned above as favoring a diagnosis of benign ulceration, cannot be relied on. Cole[3] has pointed out that this shortening of the lesser curvature and puckering of the rugae are characteristic in certain types of infiltrative carcinoma. He stressed lack of pliability as the most delicate of the findings on which a diagnosis of gastric carcinoma can be made.

Not denying the value of the test of pliability we are, however, from our experience with lesions in this region inclined to favor the viewpoint of Rivers and Dry.[12] Not restricting their discussion to disease in the prepyloric region they cited cases demonstrating the unreliability of practically every sign and symptom employed to distinguish the benign from the malignant gastric ulcer exemplifying errors in each direction. Pointing out that a carcinomatous lesion may at times exhibit apparently favorable progress under approved medical treatment they stated that "no infallible means except microscopic investigation can be applied to prove the benignity of the lesion under consideration. . . . It is hazardous to assume that the application of certain criteria of benignancy rules out the possibility of malignancy."

CASE VIII. S. H. C. (S38491), male, aged thirty-two, Chinese, was referred to this hospital complaining of stomach trouble for three or four years. During that period of time he had seen at least ten doctors, had been in two hospitals for gastric ulcer treatment and had been intermittently on milk and cream feedings with powders. There had been a weight loss of 50 pounds and weakness was such that he had been unable to work for a year. On admission in January, 1930, the physical examination was negative except for pallor and evidence of weight loss. The gastric analysis showed *free acid of 40 and total acidity of 60* with a negative benzidine reaction, although the stools were

positive for occult blood. Roentgen examination showed sluggish peristalsis but no residue at six hours. There was constant irregularity of the lesser curvature from the incisura to the pylorus with a central crater 12 mm. in width and 4 mm. in depth. The distal 3 cm. of the greater curvature was also irregular but both curvatures appeared flexible at roentgenoscopy. Palpation revealed a ridge-like filling defect parallel to the lesser curvature, probably on the posterior wall. The duodenal cap showed a constant irregular deformity with retraction of the superior surface and a deep notch, apparently indicating duodenal ulcer. There was no tenderness and no mass could be palpated. Impression: duodenal ulcer; gastric carcinoma (Fig. 9).

Fig. 9. Case VIII. (X61767) Small irregular crater 12 mm. in width, 4 mm. in depth; also scarred duodenal ulcer.

On a Sippy regimen with powders and belladonna later supplemented by gastric aspirations the symptoms were controlled satisfactorily. Re-examination February 21, four weeks after the first roentgen examination, showed the antrum to be much smoother than before and flexible but still somewhat narrowed. Palpation revealed only a small defect where the large ridge-like defect had previously been noted. The notch in the duodenal cap was much smaller than before. Impression: healing gastric ulcer; duodenal ulcer (Fig. 10). Because of the marked symptomatic improvement and the change in the roentgen picture, carcinoma was considered improbable.

In March, 1931, the patient again entered the hospital, this time with a clinical diagnosis of possible perforation of a peptic ulcer. At operation no free fluid was found in the peritoneal cavity. On the anterior aspect of the stomach, about 4 cm. proximal to the pylorus and ex-

Fig. 10. Case VIII. Three weeks after Figure 9. Crater smaller, antrum more flexible.

Fig. 11. Case VIII. Three weeks after excision of ulcer and posterior gastroenterostomy. Roentgenoscopy showed an indistinct ulcer crater still present.

FIG. 12. Case VIII. Six years after Figure 11. Note large filling defect involving distal half of stomach and obstructing the gastroenterostomy.

tending across the margin of the lesser curvature, there was the white scarred area of an ulcer 1.5 to 2.0 cm. in diameter surrounded by a broad ring of induration but there was no evidence of recent perforation. The core of the ulcer was excised with the cautery, the wall proving to be 12 to 15 mm. thick, and a posterior gastroenterostomy was done. Pathological examination showed the excised tissue to be almost leathery in consistency and there was no evidence of gastric mucosa on its surface. The pathological diagnosis was "chronic gastric ulcer; no evidence of tumor." Postoperative progress was satisfactory. It was discovered that the acute pain thought due to perforation had been caused by renal calculi. Roentgen examination three weeks after operation still showed an indistinct crater present in the antral third of the stomach (Fig. 11).

During the next few years the patient's condition was variable. Except while in China for a year and a half he would usually have troublesome pain much the same as that which had brought him here in the first place; various measures helped little. Anemia became marked and weakness so severe that in February, 1937, he was again admitted to the hospital. Examination now showed an emaciated individual with marked pallor. An irregular rocky-hard mass about 6 cm. in size was present in the left epigastrium. Gastric analysis showed *no free acid even after histamine and the total acid did not rise above 15 points*. Roentgen examination disclosed a definite filling defect at the site of the mass; it involved the antrum and the edge of the stoma leaving only a narrow channel 5 cm. in length through which the barium emptied poorly (Fig. 12). The findings suggested carcinoma. This was confirmed by operation at which a resection was done. The pathological diagnosis was carcinoma of the stomach with metastases to the regional lymph nodes.

Fortunately the specimen obtained at the original operation in 1931 was still available. More sections were cut from it and they were found to contain carcinoma with cells similar to those of the tumor removed in 1937.

The moral of this is that the pathological examination to be reliable must be complete; serial sections of the whole of the ulcer are necessary before carcinoma can be excluded. And it is worthy of note that at times even pathologists cannot agree. Cole[4] has shown that there may be considerable difference of opinion regarding the malignancy or benignancy of gastric ulcerative lesions among even the leading pathologists.

Considerable difference of opinion exists over the possibility of the benign ulcer becoming malignant. Haudek[7] stated that his experience agreed with the facts established by Orator,[9] that about one-third of prepyloric ulcers undergo cancerous degeneration. Rienhoff and Baker,[11] however, expressed the opinion that an ulcer is either malignant from the beginning or else does not become malignant; later in their paper they advocated surgery "to avoid the occurrence of malignant change in a chronic ulcer." Bloomfield[2] presented evidence purporting to show that, in 9 of a series of 22 cases, carcinoma in various portions of the stomach had been preceded by benign gastric ulcer. In support of this theory he pointed out that in many of them the carcinomatous tissue was restricted to a small group of cells at

one edge of or in the base of the ulcer. This feature has been observed in several of the cases of malignant prepyloric ulcer in our series. It would seem that when carcinomatous tissue is present in only one small part of the edge of or base of an ulcer it would be quite illogical to attribute the whole of the ulcer to the small group of carcinoma cells. However, Ewing[5] has shown that the original cancer may become reduced to a narrow ring lying just beneath the overhanging edge of the ulcer

pyloric region? As noted above, the most dependable means of differentiation is microscopic examination. Some writers have advocated watchful waiting. When these lesions have such a high probability of being or becoming malignant are we reducing total mortality by delaying operation until such time as the evidence definitely indicates carcinoma? By this time, because of metastasis to the lymph nodes, hope of cure may be out of the question. Gastric resection (Table II) in the hands

TABLE II

RESULTS OF RESECTION—BENIGN PREPYLORIC ULCER

Case	Age	Year	Operation	Result
F.F.N.	58	1928	Polya	Well at 6½ years
J.A.F.	74	1929	P.G.E.	Died 2 days postoperatively, vascular failure
J.D.S.	48	1928	Resection	Died 7 weeks postoperatively, subdiaphragmatic abscess
M.D.	48	1929	Billroth No. 1	Well at 4½ years
W.A.O. (VII)	35	1932	Resection	Well at 6 years
S.E.M.	55	1932	Horsley	Died at 6 years, nephritis
A.O.P.	44	1936	Billroth No. 1	Well at 2 years
*C.K.	44	1935	Horsley	Well at 3 years
†L.A.P. (IX)	53	1922	Resection	Died at 4½ years, metastases in brain and lungs (source?)
†J.T.S. (X)	30	1923	Billroth No. 2	Carcinoma of stomach 10 years later—new lesion (?)

* Ulcer on pyloric ring.
† Pathological report—no carcinoma at original operation.

Operative mortality—20%.
Operative mortality for gastric resection at this hospital, 1932 to 1936—17% (12 deaths in 71 cases).
Operative mortality for all operations, 1923 to 1937–4.7%.

and that its presence there is no indication that the cancer is the sequel of the ulcer. Nevertheless he did not definitely deny the possibility of carcinoma developing in a chronic ulcer. In those cases where a long history typical of ulcer is present and an early carcinoma is found by roentgen examination it is, however, illogical to conclude that a gastric ulcer has undergone malignant change. In several such cases we have found a concomitant duodenal ulcer, amply explaining the long period of ulcer distress.

What course should be followed when the roentgenologist has demonstrated the presence of an ulcerative lesion in the pre-

of a capable surgeon not only offers the best prognosis in cases of early carcinoma but even in those cases which prove to be benign ulceration such an operation may be of benefit. It is our opinion that the patient should be given the benefit of the doubt, the benefit of a microscopic diagnosis and a radical operation.

SUMMARY AND CONCLUSIONS

1. Chronic ulcers in the prepyloric inch of the stomach are found to be cancerous in 75 per cent of our cases. It may be necessary to cut many histological sections through the excised ulcer to find the area of carcinoma (see Case VIII).

2. These small prepyloric ulcers defy differential diagnosis by all methods of examination except histological and even the pathologists have erred in some of them.

3. Proved cases of prepyloric malignant ulcers are herewith reported: (*a*) in young persons, (*b*) with high gastric acidity, (*c*) with clinical improvement under ulcer therapy, (*d*) with decrease in the size of the ulcer under alkaline therapy and (*e*) with roentgen findings simulating benign ulcers.

4. We believe that prepyloric ulcers which do not disappear entirely in a few weeks should be treated by radical resection, and even those that disappear should be carefully followed and re-examined periodically.

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A CLINICAL STUDY OF THE REACTIONS FOLLOWING EMPLOYMENT OF PITRESSIN IN CHOLECYSTOGRAPHY

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FOR reliable cholecystographic diagnosis the series of roentgenograms must be of the highest quality and all factors that would hamper faithful depiction and ready interpretation of the shadows of the biliary tract must be eliminated as far as possible. Accordingly, roentgenologists have given to cholecystographic technique the attention commensurate with the importance of this diagnostic procedure. The reliability of the method thus has been greatly enhanced. One obstacle to satisfactory diagnosis, namely, obscuration of the cholecystogram by intestinal gas, has been especially difficult to overcome. Corrective measures such as enemas, the administration of charcoal, special diets and abdominal massage have been tried but none has proved consistently effective. About two years ago hypodermic administration of pitressin was introduced and its efficiency has been established by extensive trial. The use of this agent, however, is attended with certain reactions that are disagreeable to the patient and sometimes are alarming to the observer, although grave results have not been reported. It may be timely, therefore, for us to relate our own experience with pitressin and to present a detailed analysis of the reactions in a special series of cases.

The origin of pitressin was in 1928 when Kamm, Aldrich, Grote, Rowe and Bugbee described a method for the separation of the active principles of the posterior lobe of the pituitary gland into an oxytocic principle and a pressor principle. This pressor principle was named "beta hypophamine" and the solution containing the substance was designated vasopressin or pitressin. The oxytocic principle is known to cause contraction of the uterus. The pressor principle or pitressin, on the other hand, was shown by Bugbee and Simond in 1928 to have a diuretic-antidiuretic effect on anesthetized animals, generally causing an initial retardation followed by great increase of the flow of urine. Among normal unanesthetized animals the predominating effect was suppression of the flow of urine. This antidiuretic effect on normal men was reported first by Gargle, Gilligan and Blumgart. Since then pitressin has been employed in several large clinics for the treatment of diabetes insipidus.

In 1929 Rowe demonstrated the pressor action of pitressin on the blood pressure of dogs anesthetized with chloretone and showed that pitressin elevated the blood pressure as does the unseparated extract of pituitrin. However, he found that with anesthetics other than chlorotone "even when the anesthesia was fairly deep, the blood pressure was not low enough to prevent an occasional depressor reaction." Melville in 1936, working on unanesthetized dogs, demonstrated that pitressin injected intravenously causes a fall of blood pressure (contrary to the effect on anesthetized dogs shown by Rowe), stimulation of intestinal activity and of defecation. In view of its effect of increasing the tone of the bowel, pitressin has been used clinically since then for the relief of postoperative gaseous distention.

In 1936 Collins and Root published the first report of the use of pitressin to eliminate intestinal gas during cholecystog-

raphy. Since then they have published two further comprehensive reports reviewing the results in 300 cases in which pitressin was given. They found it necessary to give pitressin to 10 per cent of their patients for cholecystography and produced effective results, that is, elimination of confusing shadows in the intestinal tract in 90 per cent of cases by using the newer ampule containing 20 pressor units per cubic centimeter. Poorer results were obtained with the ampules formerly used which contained 10 pressor units. Seventy-five per cent of their patients had a stool within a half hour after the injection. Taking the blood pressure before injection and one hour after injection, they observed a drop in blood pressure in 60 per cent of their cases and a drop in both systolic and diastolic blood pressures in 45 per cent of cases. The average drop in systolic blood pressure was 12 mm. of mercury and the average drop in diastolic pressure was 12 mm. of mercury. Twenty per cent of the patients had an increase in blood pressure with an 8 per cent increase in both systolic and diastolic blood pressure. The average increase in systolic pressure was 9 mm. of mercury and the average increase in diastolic pressure was 12 mm.

Kenning and Lofstrom in 1937 reported their results with pitressin in cholecystography, urography and roentgenography of the lumbar spine in a series of 1,000 patients the majority of which were hospitalized in bed. They reported an acceleration of pulse rate and a rise in blood pressure without giving any statement as to amount or interval. They mentioned that subjective complaints such as cramps, sensations of giddiness, weakness, cold perspiration and slight nausea were rarely encountered and were fleeting in character. They also noticed occasional blanching. They found that the greater number of reactions were encountered among patients who were dehydrated and that a glass of water given at the time of injection minimized the symptoms.

Paul and Beatty recently reported using pitressin in 27 out of 98 cholecystographic examinations with good results in 63 per cent of cases. They did not take readings of blood pressures.

All the above investigators found the optimal time of making the cholecysto grams to be from thirty to sixty minutes after the administration of pitressin, because after that interval the gas returned. They considered pitressin to be contraindicated among persons having a systolic blood pressure greater than 150 or less than 100 mm. of mercury and in cases of coronary sclerosis and thrombosis, cardiac decompensation and acute complete mechanical intestinal obstruction. Kenning and Lofstrom believed that pregnancy, up to the sixth month, was not a contraindication to its use.

After studying closely the favorable reports from several other clinics we began to employ pitressin at The Mayo Clinic during the summer of 1936. Patients were prepared for examination in the usual way by instructing them to eat a meal free of fat the evening before examination and to take the solution of sodium tetraiodophenolphthalein within an hour. Also they were instructed to take an enema the next morning and report without breakfast for the first set of cholecystograms at the fourteenth hour. Before making the second set at the sixteenth hour, the first set was inspected to see whether or not the gallbladder had been obscured owing to gas in the intestine. If so, the patient was given an injection of 1 cc. (20 pressor units) of pitressin into the deltoid muscle. Among a total of about 17,000 cholecystographic examinations made during the two years since this procedure was instituted, more than 4,000 (23 per cent) of the patients were given pitressin. As familiarity with the effects of the agent increased, the proportion of patients who received the drug increased progressively and approached 40 per cent in the first eight months of 1938.

Before this procedure was inaugurated re-examination of approximately 25 per cent of patients was necessary, chiefly on

TABLE I

EFFECTS OF ADMINISTRATION OF PITRESSIN ON BLOOD PRESSURE

Patients	Sex	Age, years*	Weight, pounds*	Height, inches*	Blood Pressure, mm. Hg*											
					Systolic						Diastolic					
					Before injection	Minutes after injection					Before injection	Minutes after injection				
						15	30	45	60	90		15	30	45	60	90
46	M	47.6	161	68	114	111	107.2	106.4	104.3	102	74.5	72.6	70.3	69.3	67.9	67.9
54	F	44.1	141	64	115.7	109.7	107.9	106.7	105.3	103.8	75.0	72.5	72.4	71	70.1	71.1
100	M and F	45.7	150.2	65.8	115	110.3	107.6	106.6	104.9	103	75.3	73.6	71.5	70.2	69.1	69.6

* Arithmetic mean.

account of intestinal gas. Since pitressin has been given the proportion of re-examinations has been reduced to about 5 per cent. This change represents the efficacy of the method fairly. Reactions were of common occurrence and to determine their frequency and severity a special study of 100 patients who received pitressin was made.

During the period of investigation 5 patients were selected daily in whose cholecystograms taken at the fourteenth hour the region of the gallbladder was obscured by gas in the colon. Patients for whom pitressin was contraindicated on advice of referring physicians were excluded from the group. The selected patients were asked to remain seated and inactive except when it was necessary for them to go to the toilet or to go for the second cholecystogram a half hour after injection. After a period of rest of five to ten minutes the initial blood pressure and pulse rate of each patient were recorded. The patients then were given 1 cc. (20 pressor units) of pitressin, usually into the right deltoid muscle. Subsequently the blood pressure and pulse rate were recorded at intervals of fifteen minutes for one and a half hours and the patients were observed closely for any reaction they might have from the drug (Tables I and II).

From previous observation it had been learned what symptoms and signs might be expected so that the following were included in the record: headache, faintness, dizziness, nausea, vomiting, tinnitus, visual disturbances, pallor, belching, intestinal cramps, expulsion of gas through the rectum, bowel movements, uterine cramps, paresthesias and perspiration. These were all recorded as to time of onset after injec-

TABLE II

EFFECTS OF ADMINISTRATION OF PITRESSIN ON PULSE RATE

Patients	Sex	Age, years*	Weight, pounds*	Height, inches*	Pulse Rate per Minute*					
					Before injection	Minutes after injection				
						15	30	45	60	90
46	M	47.6	161	68	75.7	76.5	75.2	74.5	73.1	73.2
54	F	44.1	141	64	80.4	82.4	80	78.7	77.6	77.7
100	M and F	45.7	150.2	65.8	78.2	79.7	77.8	76.8	75.5	75.5

* Arithmetic mean.

TABLE III

EFFECTS OF ADMINISTRATION OF PITRESSIN ON BLOOD PRESSURE AND PULSE RATE OF 5 ADDITIONAL PATIENTS

		Pulse rate per minute*	Blood pressure, mm. Hg*	
			Systolic	Diastolic
Before injection		79	117	83
Minutes after injection	2	80	122	88
	4	74	113	82
	6	75	104	71
	8	75	110	60
	10	86	104	67
	12	77	103	72
	14	78	103	72
	16	78	103	73
	18	79	105	70
	20	79	105	72
	22	77	102	69
	24	79	101	70
	26	77	101	70
	28	76	102	70
	30	78	98	70

* Arithmetic mean.

tion of pitressin, degree of intensity and duration. The degree of intensity was recorded as 1 plus for the minimal reaction and 4 plus for the maximal reaction.

After the fourteen-hour, sixteen-hour and twenty-hour films were developed they were compared and were graded as to the amount of obscuring gas present in the vicinity of the gallbladder. Again, 1 plus indicated the minimum amount of gas in the vicinity of the gallbladder whereas 4 plus indicated that the region was completely obscured by gas. The notation zero indicated that gas was not present.

After completing the series of 100 patients and after failing to find the anticipated rise in blood pressure as described by several earlier investigators, except in a few cases, we thought there might be a rise during the early interval of fifteen or thirty minutes which might have been overlooked. Therefore the blood pressures and pulse rates were recorded at intervals of two minutes for a half hour on an additional series of 5 patients who had been given pitressin (Table III).

Also we found that a gradual fall of blood pressure occurred during the ninety minutes of observation. We thought that this was not the result of administration of pitressin. As a control we observed the blood pressures and pulse rates of an additional 10 patients (5 men and 5 women) who were having cholecystographic examination, but who were not given pitressin. The readings were taken at intervals of fifteen minutes just as was done in the experimental group of cases (Table IV).

TABLE IV

BLOOD PRESSURE AND PULSE RATE OF 10 PATIENTS AT REST WHO HAD NOT RECEIVED PITRESSIN

		Pulse rate per minute*	Blood pressure, mm. Hg*	
			Systolic	Diastolic
Initial reading		82	117	77.2
Minutes after initial reading	15	83.6	112.6	73.8
	30	83.2	113.6	76.4
	45	82.6	110	74.2
	60	79.8	105.4	74.8
	90	80	105.8	73.4

* Arithmetic mean.

This series of 100 patients consisted of 46 men and 54 women of an average age of forty-five years and an average weight of 151 pounds. Tables I and II give the average age, weight, height, blood pressure and pulse rate before and after the administration of pitressin for the series of 100 patients and separately for the men and women.

Of the entire group there were 58 patients whose systolic blood pressures fifteen minutes after pitressin had been given were decreased, 36 whose systolic blood pressures were increased and 6 whose systolic blood pressures were unchanged. After thirty minutes the blood pressures of 70 patients were decreased, of 24 were increased and of 6 were unchanged; after forty-five minutes the blood pressures of 71 patients were decreased, of 23 were increased and of 6 were unchanged; sixty minutes afterward the blood pressures of

83 patients were decreased, of 11 were increased and of 6 were unchanged and after ninety minutes the blood pressures of 82 patients were decreased, of 13 were increased and of 5 were unchanged. The highest individual rise of blood pressure was 20 mm. of mercury. This occurred in a case in which the initial systolic blood pressure was 88 mm. of mercury, whereas thirty minutes later it was 108 mm. However, the patient had just returned from the lavatory when it was time to take the reading so that one would suspect that this was a physiologic rise due to increased activity. In several other instances an increase in blood pressure was noted at times when patients had just returned from having had another cholecystogram made or when in some other way they had altered their restful posture. Individual instances of lowered blood pressure were seen when patients had severe pallor and intestinal cramps.

Although most of the earlier investigators believed pitressin to be contraindicated in cases in which the systolic blood pressure was greater than 150 or less than 100 mm. of mercury, this series included 3 patients whose blood pressure was more than 150 mm. of mercury and in all three the blood pressure decreased slightly after injection. Also there were 19 patients whose blood pressures were less than 100 mm. After pitressin was given the blood pressure was elevated in 11 cases, slightly lowered in 5 and unchanged in 3.

In Table 1 it will be observed that the diastolic blood pressure was altered proportionally to the systolic pressure. This is likewise true of the pulse rate (Table II), except that there was an increase in the average pulse rate at an interval of fifteen minutes after injection.

The small series of 5 additional patients whose blood pressures and pulse rates were recorded every two minutes for a half hour showed a slight elevation in blood pressure and pulse rate two minutes after injection, whereas all later readings showed a general decline (Table III).

Observations on control series of 10 patients to whom pitressin was not administered showed a similar fall in blood pressure and a decrease in pulse rate after sitting one and a half hours, the same period of rest as used in the study of the larger group of patients who had pitressin (Table IV). Among signs and symptoms, pallor and complaint of intestinal cramps were by far the most frequent. Table V shows the incidence, type and degree of the various reactions encountered, the average time of onset of the reaction after pitressin was administered and the duration of the reaction in minutes. One patient also complained of feeling very sleepy although not in any way distressed or uncomfortable. Three patients complained of cold perspiration and 2 others said that they had experienced tingling and numbness of the feet and hands.

Pallor was usually the first indication of a reaction and it occurred five to ten minutes after pitressin was injected. Faintness and dizziness usually were associated and headache seldom occurred unless the patient also experienced faintness or dizziness. Naturally, vomiting always was preceded by nausea, whereas nausea was

TABLE V

REACTIONS OF 100 PATIENTS TO PITRESSIN

Patients	Symptoms and signs	Reaction		
		Grade, on basis of 1 to 4*	Onset after injection, minutes*	Duration, minutes*
4	Tinnitus	2.0	8.7	37.7
4	Visual disturbances	2.0	15.0	52.5
7	Vomiting	1.0	10.7	8.8
11	Headache	1.7	11.8	70.9
20	Uterine cramps	1.9	19.5	60.5
47	Nausea	2.1	10.4	42.5
49	Dizziness	1.8	9.5	59.7
55	Faintness	2.0	8.5	50.1
58	Belching	1.7	11.8	39.6
71	Defecation		17.5	
72	Gas per rectum	2.2	16.4	36.2
81	Pallor	2.1	7.1	68.2
82	Intestinal cramps	2.0	10.9	54.9

* Arithmetic mean.

TABLE VI

INCIDENCE OF UTERINE CRAMPS AFTER ADMINISTRATION OF PITRESSIN

	Menstruation		Menopause
	Less than 15 days previously	More than 15 days previously	
Women	20	12	22
Per cent	55	25	27

always associated with increased intestinal activity, as indicated by intestinal cramps or the passing of gas by rectum. It is possible that more than 72 patients (Table v) passed gas by rectum because some of the patients were embarrassed and appeared hesitant in reporting the occurrence. It is believed that a larger number of patients pass gas when they are permitted to be alone in a dressing booth than when, as was necessary in our investigation, groups of 5 patients are placed in the same room. Many of the patients passed considerable quantities of gas when they went to the lavatory for a bowel movement, which usually occurred about fifteen minutes after injection. Tinnitus and visual disturbances were rare and of little significance.

Of considerable interest is the fact that 20 women (37 per cent) complained of pelvic pain resembling menstrual or uterine cramps distinctly different from intestinal cramps, although usually associated with the latter. The date of onset of the last menstrual period was obtained from each woman and the women were divided into three groups. The first was composed of those whose periods had occurred within the previous fifteen days, the second group was composed of those whose periods had occurred more than fifteen days previously and the third group consisted of women who had passed through the menopause. In Table VI it will be seen that by far the greatest incidence of uterine pains occurred among the women of the first group who had had their periods less than fifteen days previously. Young women of athletic type generally experienced the most severe uterine cramps. This series included one such woman who had such a severe reaction that she fainted. She is included in the first group in Table VI and her period had occurred ten days previous to the examination. The older women who appeared frail usually experienced the least effect on the uterus.

In Table VII it will be seen that men and women reacted alike and in about equal numbers, except, of course, as regards uterine cramps.

In comparing and grading the cholecystograms the fourteen-hour film always had 1 plus to 4 plus of gas in the vicinity of the gallbladder, with an average of 1.82 plus. The average of the sixteen-hour films, which were taken about a half hour after pitressin was given, was 0.72 plus or less than half the amount seen in the fourteen-hour films. The average of the twenty-hour films was 1.06 plus, showing a definite return of gas, although not so much as before pitressin was given. In general it can be said that in 83 per cent of the cases obscuration of the cholecystogram owing to gas was lessened or was eliminated completely, was unaltered in 13 per cent and was increased definitely in 5 per cent. Be-

TABLE VII

COMPARISON OF INCIDENCE OF REACTIONS TO PITRESSIN AMONG 46 MEN AND 54 WOMEN

Symptoms and signs	Per cent	
	Men	Women
Tinnitus	4.3	3.7
Visual disturbances	4.3	3.7
Vomiting	6.5	7.3
Headache	6.5	14.0
Uterine cramps		37
Nausea	45	48
Dizziness	50	46
Faintness	56	51
Belching	52	70
Gas per rectum	78	66
Defecation	82	64
Pallor	82	79
Intestinal cramps	84	77

cause the patients on whom this study was made were assembled necessarily in a group for observation and were limited in activity so as to avoid disturbances of blood pressure and pulse rate, it is believed that the results obtained are not as good as we would expect to obtain in our routine cholecystographic work in which patients are allowed more freedom to move about, have more privacy and no doubt feel freer to expel gas from the rectum.

COMMENT

There seems to be prevalent an assumption that pitressin raises blood pressure and that therefore its use in cases of hypertension is dangerous. In experiments by Rowe and Melville on dogs, it was noted that pitressin may have either a pressor or depressor action, depending on the state of the animal. In Rowe's experiments in which the dogs were depressed deeply under the anesthetic influence of chloretone, pitressin seemed to have only a pressor effect. Melville, on the other hand, working with dogs that were not anesthetized and therefore had not already been depressed, found that pitressin had a depressor effect. Although it is not possible to draw a close analogy between the results of animal experimentation and clinical observation, we can say that in no individual case of ours was pitressin the means of raising or lowering the blood pressure to any dangerous extent and in the average of 100 cases there was no effect on blood pressure except possibly a small transitory rise within the first two minutes after administration of the drug (Table III). However, this might even be a rise of psychic origin owing to the pain and anxiety caused by the hypodermic injection.

The results of the experiments of Collins and Root closely approximated ours in that Collins and Root observed a drop of 12 mm. of mercury in both systolic and diastolic blood pressures at the end of an hour. We observed a drop of 10 mm. in an hour and 12 mm. at the end of one and a half hours. However, we demonstrated that this was a physiologic drop, independent of the action of pitressin on our group of controls who also showed a drop of 12 mm. when placed under the same conditions as those of the patients who received pitressin. Kenning and Lofstrom did not give figures to evaluate their report of acceleration of pulse rate and rise in blood pressure. Our figures tend to show a physiologic decrease in pulse rate similar to the fall of systolic and diastolic blood pressures.

The fact that 3 of our patients who had an initial systolic blood pressure of 150 mm. or greater had a slight fall of blood pressure after administration of pitressin would suggest that the conventional acceptance of 150 mm. as top limit of safety for systolic blood pressure may be too low, for apparently the suspected danger lies in further elevation of the blood pressure. Since in most of the cases in which the systolic blood pressure was 100 mm. or less an elevation of blood pressure occurred after pitressin was given, this lower limit might be lowered still further with safety. Undoubtedly patients who have coronary sclerosis, thrombosis and any degree of cardiac decompensation should not be given pitressin until more is known about the action of the drug, as has been suggested by previous investigators. Contraindications such as mechanical obstruction of the intestine are obvious and patients suffering from such a condition should not be subjected to cholecystography.

The question of pregnancy as a contraindication to such a procedure is still unsettled, although Kenning and Lofstrom believed that pregnancy of six months' duration or less is not a contraindication. Pitressin is described as being the separated pressor principle of the posterior lobe of the pituitary gland. It is supposed to be relatively pure and free from the oxytocic principle of the posterior lobe of the pituitary gland which causes contraction of uterine muscle. However, our experience revealed that 37 per cent of the women given pitressin experienced definite uterine cramps, which would suggest that either

the product still contains some oxytocic principle, possibly an impurity, or that pitressin itself has some direct or indirect action on the human uterus not manifest in laboratory experimentation. We have also found that a higher percentage of women suffer from cramps if the menstrual period has occurred within the preceding fifteen days than after that interval. If possible, therefore, one should defer giving pitressin until the latter half of the menstrual cycle.

In reviewing the various reactions produced by pitressin it is noteworthy that about the same number of men as women are affected. Without investigation one might guess that a greater percentage of women would be affected since they are generally thought to be of the weaker sex and on the average are smaller in stature than men.

Perhaps the most impressive reaction is that of pallor. When first beginning to use pitressin, the physician may become much concerned about his patients until experience demonstrates that pallor is of common occurrence and usually outlasts the other reactions. Often the patient has a sallow hue and thus has the appearance of being more ill than he probably is. If the patient sees his image in a mirror he is usually surprised at his color and often he admits that he appears sicker than he feels. Some, however, on either seeing themselves or on being informed of their appearance by other patients, become faint and frightened. A word of reassurance that the condition is merely a transitory vasoconstriction is helpful at such a time.

Owing to the constricting effect of pitressin on the musculature of the bowel, intestinal cramps must be expected to occur usually within ten to thirty minutes after injection. This constriction often creates the urge to have a bowel movement, which should be permitted as promptly as possible so that the patient may expel the gas before it diffuses throughout the bowel. Generally the most appropriate time to make the cholecystogram is about a half hour after pitressin has been given. However, if the examiner is experienced and if he can afford the time to study the first (fourteen-hour) film, individual variations are often helpful in producing even better cholecystograms than otherwise would be produced. If there is only a small amount of gas overlying the region of the gallbladder, pitressin will move it in a shorter period of time than it will move numerous irregular accumulations of gas. If the shadow of gas is mottled with the characteristic picture of contained fecal material, considerably more time will be required to move it out of the gallbladder field than otherwise would be the case. In view of these differences we make some of our second (sixteen-hour) cholecystograms as soon as fifteen minutes and others as late as forty-five to sixty minutes after giving pitressin, for the return of gas is usually small and seldom interferes enough to make the diagnosis questionable.

As has been mentioned previously, pitressin has reduced the number of necessary roentgenologic re-examinations from 25 per cent to 5 per cent. It is a most useful drug in this respect, but because of the numerous and variable reactions associated with its administration, there is still much to be desired.

Kenning and Lofstrom reported a decrease in the incidence of reactions if patients are given a glass of water to drink before pitressin is administered. Although we have not followed this procedure in a large series of cases, our limited experience has not shown an appreciable difference. Perhaps the drug can be purified further, thus eliminating some of its undesirable effects, especially the uterine cramps; or it may be possible to administer some other drug to counteract the uterine cramps. We have found it helpful to give patients inhalations of aromatic spirits of ammonia when they become faint.

On the whole, in view of the foregoing considerations and the fact that fatalities have not occurred after the employment of pitressin for any purpose, it seems to be

safe for use in cholecystography if the contraindications to the use of the drug are kept in mind. Doubtless pitressin will continue to be employed as an aid to the production of better cholecystograms until it is replaced by some other agent free of association with objectionable reactions.

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THE RETICULO-ENDOTHELIAL NEOPLASIA*

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SUBSTANTIAL arguments can be put forward in favor of dividing the various tumors with which we are concerned in therapy into three major groups:

(1) Radioresistant tumors.
(2) Tumors of limited sensitivity.
(3) The highly radiosensitive tumors.

The first group includes the tumors which arise from the fixed connective tissue elements of the body—osteogenic sarcoma, fibrosarcoma, and similar types. They have all been shown to be radioresistant. The second group are those tumors which experience has shown us to be curable only if of limited size and then only by the exhibition of high dosage of radiation. The group on review seems to include practically all "carcinomas" with the exception of embryonal types.

We do not, however, intend to submit the arguments for that classification here; it is presented merely as an introduction to consideration of the third group. When the tumors which might be put into this third group are examined it looks at first sight as if most of the waifs and strays of the tumor world belonged there. Radiotherapists have for a long time been familiar with the existence of a number of strikingly sensitive tumors, and indeed much of the earlier reputation of radiotherapy was founded on their existence. Any experienced therapist, if asked to do so, could write down quite a list of tumor types which he would expect to prove radiosensitive, and radiotherapy has now a sufficient experience behind it to make these lists cover practically identical ground. Such a list would seem to contain a large number of apparently different types of growth each presenting an independent study from the point of view of radiotherapy. So techniques are described for lymphosarcoma, for Hodkgin's disease, for Ewing's tumor, and many similar syndromes. It is our purpose in this paper to try to show that some order can be obtained out of the chaos by classifying into these three groups.

(*a*) *Embryonal origin.*
Seminoma testis.
True embryonal tumor of ovary.
(*b*) *Primitive tumors of unknown origin.*
Wilms' tumor of kidney.
Some tumors of thyroid glands.
Some tumors of salivary glands.
Some tumors of nasopharynx and nasal accessory sinuses.
(*c*) *Reticulo-endothelial origin.*
Leukemia.
Hodgkin's disease (lymphadenoma).
Lymphosarcoma (reticulosarcoma).
Thymoma.
Ewing's tumor.
Endothelioma (of vascular origin).
Miscellaneous reticulo-endothelial diseases.

The first group are the well known and long accepted embryonal tumors of the testis and of the ovary. We do not intend to consider these further here as we are chiefly concerned with the second and third groups. The second group may be looked upon for the moment merely as a list of sites where sensitive tumors are commonly found. Later we hope to show that while they may be embryonal, they are more likely to belong to the third group, consideration of which really forms the main content of this paper.

We feel that without stretching speculative hypothesis too far, all known highly sensitive tumors other than embryonal can ultimately be included in the third group shown above, comprehensive although it then becomes. When the tissue of origin of those sensitive tumors with which therapists are most familiar is considered, it

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would appear that they all rise from one or other of those parts of the body which, derived from primitive mesenchyme, are necessary for the purposes of defense, repair or blood formation. They take origin therefore in those systems which are covered by the various prefixes, hemo-, reticulo-, endothelio- and the like. For the purposes of classification it was advisable to coin a suitable and as comprehensive a word as possible for this group of tumors, and the name "the reticulo-endothelial neoplasia" seemed as complete as any of the many we considered. This name is therefore used here to cover a large variety of hyperplasias and new growths of the hemopoietic, lymphatic, and reticulo-endothelial systems of the body, a series of growths whose one common character is that they are highly sensitive to radiation. Having established such a group we believe that all sensitive tumors which are not embryonal can be shown to belong to this group and, what is more important, that for the purposes of treatment the whole group can be looked upon as one entity and not as a whole variety of therapeutic problems.

The following is a list of the more outstanding conditions which we believe to be forms of neoplasia of the primitive mesenchymal tissue and which can come under our common heading. The types are not arranged in any supposed order of radiosensitivity; familiar conditions frequently met with are listed first with some of their "aliases," followed by rarer conditions seldom diagnosed. No attempt has been made to list all the varieties which have been described and named in a voluminous literature on the subject.

THE RETICULO-ENDOTHELIAL NEOPLASIA

Lymphosarcoma
Reticulum cell sarcoma
Lymphadenoma
Hodgkin's disease
Leukemia
Myelogenous
Lymphatic
Erythrocythemia
Ewing's tumor
Endothelial myeloma
Endothelioma—of vascular origin
Hemangio-endothelioma
Angiosarcoma
Multiple reticuloses
(*a*) of lymphoid tissue
Lymphoma
Lymphomatosis
Lymphoblastoma folliculare
(*b*) of storage reticulum
Schüller-Christian
Gaucher
Niemann-Pick
(*c*) of marrow reticulum
Multiple myeloma
Plasmocytoma
Chloroma
(*d*) of mesenchymal areolar connective tissue
Multiple sarcoids (Boeck's)
Mycosis fungoides
Kaposi sarcoma
Subcutaneous lymphadenoma.

PATHOLOGY

It is a characteristic of this species that although the majority of the tumors belong fairly clearly to one or other of the well-known groups, there is in reality no gap between the common conditions which should be regarded rather as named landmarks than as isolated diseases. Many lesions lie in fact between two landmarks, carry many of the characters of each, and may be as difficult to allot to one as to the other. There is no proof other than sensitivity that some diseases really fall into this group, but where sensitivity is found the lesions so isolated will tend to carry many of the general characters of the group. Let us review certain of these landmark conditions in greater detail.

The term "*lymphosarcoma*" has in the past been used indiscriminately to include tumors composed of lymphocytes and tumors composed of reticulum cells and the classification of the different types has been still further confused by the controversy as to which is the primitive stem cell—the lymphocyte or the reticulum cell of the germinal center sometimes called a lympho-

blast. Radiosensitivity has not helped to solve this difficulty as tumors of either type show a wide range of sensitivity. Radiotherapeutically the distinction has no importance as a guide to probable lethal dose, and treatment is not influenced. Secondary deposits of lymphosarcoma in lung, bone, spleen, liver and genitourinary system are not uncommon. There is a peculiar form of reticulum cell sarcoma, often primary in the tonsil, which appears as an ulceration with no underlying tumor and may be diagnosed clinically as Vincent's angina. Biopsy usually obtains tissue thought to show "chronic inflammation," and the true diagnosis may only be made when secondary nodes appear in the cervical region or mediastinum.

The inclusion of *lymphadenoma* as a neoplasm is still open to question, but this conception of the disease has been gaining ground and is now accepted by the majority. The individual range of sensitivity of lymphadenoma is probably the most complete in the species, extending from the very sensitive "malignant Hodgkin's disease," believed by Robb-Smith to be a mixed cell reticulosarcoma, to localized nodes showing almost complete replacement of the lymphoid structures by fibrous tissue and relatively resistant.

Ewing's tumor should be regarded as a tumor of the bone marrow, not of bone. Ewing himself uses the name "endothelial myeloma" and says that it may be associated with generalized lymphoid hyperplasia. He describes three forms: angioendothelioma, reticular myeloma, and diffuse myeloma, so even the name Ewing's tumor covers a range of neoplasms of different types rather than a single easily distinguished variety. He says definitely that the spindle cells often present are not undifferentiated osteoblasts.

Angio-endothelioma is the best term available to cover several types of tumor which appear to be derived from primitive angioblasts and which range from simple hemangioma to very malignant tumors which show some hemangiomatous structure. Both benign and malignant types are radiosensitive. It must be noted that not all tumors called "endotheliomas" are sensitive. Resistant tumors of apparently endothelial origin are found in pleura, peritoneum and synovial linings of joints and tendons. These must be held to be of the same type as the other fixed connective tissue tumors. At present there seems to be no histological method of ascertaining to which main group such a tumor belongs and distinction must be made by a radiosensitivity test.

Multiple reticulosis is a wide term covering a number of relatively rarer conditions. The lymphoid types are very closely associated with lymphatic leukemia, and to be exact really include the landmark diseases lymphosarcoma and lymphadenoma. The lesions met with range from simple hyperplasia to rapidly fatal multiple neoplasia of all the lymphoid elements of the whole reticulo-endothelial system. It may be questioned whether the reticuloses of bone marrow should be described separately from Ewing's tumor, but multiple myeloma is ordinarily recognized as an entity. Plasmocytoma is fairly often described and may be derived either from the endothelial cells of the marrow sinuses or actually from hemopoietic cells, the last being responsible for tumor formation associated with leukemia. Reticuloses of the mesenchymal areolar tissue is a useful term to cover a collection of rare conditions not yet clearly defined, but explaining the presence of multiple sensitive tumors and reticuloses in subcutaneous, retroperitoneal and other tissues.

Once the idea takes root in the mind that tumors in any way akin to these landmark conditions are likely to belong to this group of reticulo-endothelial neoplasia, it is literally surprising how many other diseases to which it is difficult to give any definite name with satisfaction can be duly christened and be found to live up to their reputation by proving sensitive.

Sensitive Tumors of Secretory Glands. The second group of sensitive tumors which we

listed includes a percentage of all the neoplasms found in the following organs, and tumors in these organs must therefore be presumed to be sensitive until proved otherwise.

Nasopharynx and nasal sinuses
Salivary and lachrymal glands
Thyroid
Thymus
Kidney—Wilms' tumor.

At first sight it is difficult to find adequate reasons for discussing this group as well under the heading of "reticulo-endothelial neoplasia." Undoubtedly many of the tumors in these organs are clearly of that nature, but some are tumors largely peculiar to these sites and may in fact owe their sensitivity to being of embryonal origin. All the glands involved are, however, in regions where embryonic development is extremely complex so that there is no difficulty in supposing that both primitive mesenchyme and embryonal residua might give rise to neoplasia.

The decision to deal with the apparently glandular tumors along with the rest of the group is based on practical experience of their reaction to radiation and a knowledge that many are in fact clearly reticulo-endothelial in origin rather than on a definite proof that they can all be classed as reticulo-endothelial in preference to embryonal.

In the nasopharynx particularly, nearly every name mentioned among the reticulo-endothelial neoplasias, especially endothelioma, has been attached to the tumors found, and there are in addition sensitive so-called basal cell glandular carcinomas and others resembling an embryonal tumor recognized by some radiologists and reported as papillary adenocarcinoma. In the nasopharynx the tendency for histological diagnosis to be difficult is marked because of resemblance to infection or granuloma: even after repeated biopsy the pathologist may be forced to non-committal report, and diagnosis have to depend on response. In the salivary and lachrymal glands, Mikulicz' disease is an obvious reticulosis and reticulum cell sarcoma has also been reported, but there is again a tumor usually described as an undifferentiated basal cell carcinoma which is very sensitive. In the parotid gland sensitive lesions are in a minority, but in the submaxillary salivary gland they appear to constitute the majority. In the thyroid, ligneous goiter may be regarded as a reticulosis, and there is also a true reticulum cell sarcoma. A sensitive undifferentiated tumor which may show basal cell character also occurs and is of a different species from adult glandular carcinoma or malignant change in fetal adenoma of the thyroid, neither of which is sensitive.

TREATMENT

The reason for all this lengthy discussion is not the mere pathological interest of the classification, but the fact that this conception can assist in determining treatment policy. Once the fact is established that the tumor to be treated belongs to this species, the exact variety becomes no longer important, treatment being determined solely by the size of the tumor, degree of secondary involvement, and the number or potential number of primary foci. In all such cases clinical examination is important in order to determine the presence of and degree of extension. Such examination must include palpation of all accessible lymph node areas and of the liver and spleen, a blood count, and a roentgen examination of the chest in all cases and of the bones in many cases.

Biopsy remains important because it may give the first indication that the lesion with which a patient presents is a neoplasm and must remain the only way to further information in what is still a very obscure field.

The difficulty of obtaining biopsy, and even if biopsy is carried out of interpreting the findings, often makes it uncertain whether the lesion to be treated belongs to the sensitive group. It is then necessary to carry out a sensitivity test. This consists of treating a single nodule or lymph node or

of using a field just covering a palpable tumor and giving a dose which delivered in a short time should be enough to make any sensitive tumor show some response quite rapidly, and yet not too much to prejudice subsequent treatment.

Having determined either by biopsy or by a therapeutic test that the tumor is a radiosensitive one, treatment becomes a question of treating adequate volumes of tissue and yet at the same time making the best use of available tolerance. This is best carried out by roentgen irradiation. Knowledge regarding lethal dosage range in this field is scanty, but there are indications that each of several of the better-known landmark types such as lymphosarcoma, lymphadenoma, and Ewing's tumor independently covers practically the whole range of sensitivity found in this group. It is fair to assume that this is in general true. We are not, therefore, dealing with a series of tumors each with known lethal dose beginning, say, with lymphoblastoma folliculare and ending with angio-endothelioma, but with one species containing many varieties, all of which have a potential lethal range running the whole length of the part of the sensitive scale involved. The limiting points on this range have been determined by clinical experience. It is probable that a large proportion of these tumors can be cured locally by a tumor dose of 4,000 r in three weeks, or the equivalent for any other time. As to the other end of the scale, there is fairly general agreement among experienced therapists that in spite of the spectacular immediate response very few of these lesions fail to recur after doses of less than 1,000 r fractionated over a week or two. A useful working hypothesis of the lethal range would be as shown in Figure 1. In presenting this in graph form it must be emphasized that it is not built up on a truly experimental basis but is merely a quantitative expression of clinical experience. The dose, "*x*" abscissa, is expressed in terms of the *minimum* tumor dose received. Effect, "*y*" abscissa, is expressed in terms of the percentage of cases one would expect to show complete disappearance and remain clear *in the treated zone*—it is no attempt to assess percentage survival of patients treated.

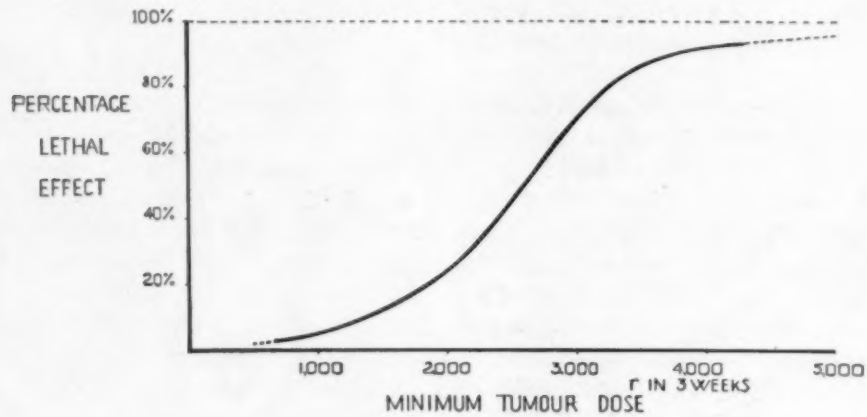

FIG. 1. Lethal dose range of the reticulo-endothelial neoplasia.

Accepting 4,000 r in three weeks as a fairly consistent lethal dose, then it follows that if it were possible to use small fields these would not in many instances require full local tolerance, but in fact it is never safe when dealing with a tumor of the sensitive species to leave only a narrow margin around the tumor, and even when dealing with a localized lesion such as lymphosarcoma of the tonsil, large fields (e.g. 15×10 cm. to include the whole neck and nasopharynx) are desirable. On the other

hand, this dose, well within the limits for even such fields, would be dangerously excessive were it necessary to irradiate the whole thorax for an extensive mediastinal involvement when the question of general tolerance must also be considered. When large sections of the body such as thorax or abdomen have to be treated, it is probably always necessary to use full systemic tolerance as indicated by the blood count on the basis that although the lethal dose for the particular lesion being treated is not known the higher the dose can be raised, the greater is the probability of lethal effect. The alternative policy is to make the total dose given depend on the initial rate of regression: this we believe not so sound in that rapidly melting tumors are as likely to require quite as high doses for lethal effect as more slowly responding lesions.

The first essential is then to treat the disease as a whole to a reasonable dose level, and a fair response should be expected at doses of 2,500 to 3,000 r, although it may be necessary to take considerably longer than three weeks to deliver this dose, if the volumes to be irradiated are large. Any additional biological effect which can be obtained is, however, of value so that if there is local tolerance in hand, especially if a localized lesion is producing symptoms, or has not resolved, this tolerance should be used to raise a limited zone within the already treated area to a rather higher dose level.

The more generalized reticuloses call for even wider treatment with radiation baths, and here the sensitivity is often so great that tumor disappearance is apparently complete with doses of 1,000 r over anything from three to six weeks. Permanent cure is, however, unlikely, because of ultimate recurrence and because the generalized nature of the disease makes the development of further new foci almost inevitable; in the end tolerance is exhausted and a fatal termination cannot be prevented. Radiation baths to the whole body (including head and limbs) cannot be regarded as a practical method of treatment even in the most ultrasensitive of these diseases, because it is impossible to deliver doses which have even a slight chance of lethal effect without so interfering with hemopoiesis that aplastic anemia must follow.

Radium therapy is never the treatment of choice in sensitive tumors and should only be considered if roentgen-ray facilities are quite unobtainable. As far as the means permit large volumes should still be irradiated either by extensive radon applicators or by wide implants. In localized reticulo-endothelial neoplasms, in the tonsil or base of tongue especially, good results have been obtained by radium, but the method although the apparent results are striking must be subject to a much higher recurrence rate. Indeed, when a local radium implant or mould produces an unexpectedly sensitive response, this should of itself be taken as adequate evidence that a change in treatment is indicated in favor of roentgen irradiation of larger volumes.

METHODS OF TREATMENT

Working on these principles, three methods of treating the radiosensitive tumor species are suggested:

(*a*) Local therapy
  (i) Curative
  (ii) Symptomatic
(*b*) Regional therapy
(*c*) Radiation baths

(*a*) *Local therapy* (*curative*) is justified when it is possible to treat a localized tumor such as a nasopharyngeal growth or a Ewing's tumor of the shaft of a long bone. The margins beyond the assessed limits of the tumor must be wide. For example, in the case of the nasopharynx, fields 15×10 cm. including the whole head and neck from side to side with a possible addition of a posterior or superior field to bring up dose while saving skin tolerance would be suitable. The dose to be aimed at is 4,000 r tumor dose in three weeks. For a Ewing's tumor, for example of the upper end of the femur, three fields 20×7.5 cm.

might be used, or for the not uncommon site in the calcaneus, lateral fields include the whole tarsus and lower third of tibia and fibula with bolus bags to ensure homogeneity.

It is not always simple to arrange these treatment fields to get a tumor dose of 4,000 r without exceeding surface tolerance, particularly when large local tumors are present, and when curative therapy is planned it is always worth while to prepare a careful scheme. Fields should be plotted and roentgenograms taken as required to give the relationship of the parts to the treatment fields.

Local Therapy (*Symptomatic*). Local treatment may also be used on purely symptomatic grounds not attempting permanent cure. This use is seen particularly in the treatment of *lymphadenoma* (Hodgkin's disease), where treatment of each isolated gland group involved seems as efficacious in the long run as more generalized treatment; 2,000 to 3,000 r in three weeks is then adequate dosage.

The same reasoning holds for the *leukemias* where although in theory the whole body ought to be irradiated, or at least the whole bone marrow system, it is a matter of clinical experience that splenic irradiation alone at quite low dosage gives as useful symptomatic relief and as good survival. These blood diseases are uniformly fatal but in the chronic form may sometimes be almost completely relieved and life considerably prolonged by carefully controlled radiotherapy.

(*b*) *Regional Therapy*. This method is indicated when there is any real probability that the disease has extended beyond the primary site of neoplasia even if such extension cannot be clearly demonstrated. It is the appropriate method of such lesions as bilateral lymphosarcoma of the cervical lymph nodes extending down to the clavicles, for lymphadenoma of supraclavicular and axillary lymph nodes, for Ewing's tumor of the pelvic bones, for mediastinal tumors or for lymphosarcoma of inguinal nodes.

It is clear that it would sometimes be possible by taking some risk with the volumes treated and by using full tolerance both locally and generally to get a minimum dose considerably higher than 3,000 r, but the added percentage of local cures which may be obtained by such high doses is rather uncertain and probably not great. Any advantage is almost certainly outweighed by the greater loss of tolerance which ensues and which will prevent the treatment of metastases or new foci of neoplasia should they occur.

In regional therapy the segment of the body irradiated in one piece is large though not so great as is involved when full thoracic or radiation baths are required. The commoner regions so dealt with are: the whole head and neck, the whole neck with contiguous base of skull and upper mediastinum, the whole shoulder and one hemithorax, the mediastinum and contiguous lung, the pelvis, the half pelvis with contiguous side of abdomen and upper thigh. The simplest scheme of treatment is by two fields anteroposterior and posteroanterior and where possible a third field to raise the dose in the center is valuable. There are, however, a variety of possible field arrangements which may be used as indicated. Rather over 3,000 r can be given on the surface in three to five weeks, but even so the minimum dose in the center will usually be somewhat under 3,000 r.

(*c*) *Radiation Baths*. It is frequently necessary to treat the whole thorax, whole abdomen or even the whole trunk in the more generalized forms of reticulo-endothelial neoplasia. The mediastinum, cervical, supraclavicular and axillary lymph nodes may all be involved simultaneously by reticulosarcoma or a lymphadenoma. Abdominal baths are indicated for the reticuloses of inguinal and abdominal lymph nodes, and for retroperitoneal sarcoma, which sometimes falls into the sensitive class.

The whole trunk may have to be irradiated for any of the generalized reticuloses. The results are not, however, very satisfactory.

With irradiation of abdomen alone, it is possible to achieve in many cases doses of 3,000 r, but over a period of from five to eight weeks. With irradiation of the thorax 2,000 r is about all that can be achieved without blood drop stopping treatment. Details of the best techniques of treatment are outside the scope of this paper.

PROGNOSIS

What are the prospects of cure? Given satisfactory treatment, this depends almost wholly on the extent of the lesion and on the particular type. Those lesions which when first seen are generalized or those types which by their very nature are generalized, such as the multiple reticuloses, lymphadenoma, or leukemias, cannot be cured, but the increased expectation of active life resulting from correct treatment has real value.

Those types, on the other hand, which in the beginning do appear to be single lesions such as the lymphosarcoma and angio-endothelioma *are curable* as long as they remain single—indeed can fairly consistently be cured in the treated area where a dose of 4,000 r can be achieved. For this reason the planning and the supervision of treatment in such cases fully merits meticulous and time consuming work, especially if, as is so often the case, the lesion occurs in young people. Perhaps one of the most tragic events of poor radiotherapy is seen in the treatment of this type of lesion—inadequate dosage over a vaguely defined area, the futility of the effort being masked by the immediate spectacular response.

Even when the lesions have produced metastases they can still be cured in a percentage of cases treated provided that the metastasis is of limited extent and occurs in one metastatic field only, even if that be the lungs.

Thus, although as a rule treatment of the reticulo-endothelial neoplasia is disappointing, certain of them are eminently responsive and provide some of the most satisfactory results of present-day roentgen therapy.

METASTATIC PULMONARY INFILTRATIONS OF INFLAMMATORY ORIGIN*

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THE roentgenological aspect of isolated or multiple round pulmonary infiltrations has been of great interest because of various pathological conditions responsible for their occurrence. A large volume of roentgenological literature concerning the differentiation of these infiltrations has been accumulated. The most frequently encountered infiltrations are malignant metastases. Tuberculosis, especially the Assmann type, accounts for a large percentage of these infiltrations. Parasites have also been described producing this kind of lesion.

A search of the literature does not reveal any reference to pulmonary infiltrations caused by suppurative inflammations that have metastasized from other organs.

At the University Hospital we had the opportunity to observe a series of cases in which an extrapulmonary suppurative process caused respiratory complications, and in which the roentgenological examination of the chest demonstrated changes of a quite typical character. These were pulmonary infiltrations resembling, to a great extent, malignant metastases. We feel a brief discussion is justified, as they are found rather infrequently, and may be misinterpreted.

REPORT OF CASES

CASE 1. T. J. N., white boy, aged thirteen, entered the University Hospital on August 19, 1933, complaining of headache, pain in the chest, and dry cough. Two months prior to admission he had been treated for an acute frontal sinusitis. The infection spread very early and resulted in an extensive cellulitis of the frontal area of the scalp. Surgical drainage of the abscess did not prevent the infection from involving a large portion of the skull. On examination there were signs of increased intracranial pressure, headache, vomiting, and choked discs bilaterally; no localizing signs were present. Examination of the chest revealed no signs referable to pulmonary pathology.

Roentgenograms of the skull showed an extensive osteomyelitis involving the frontal and

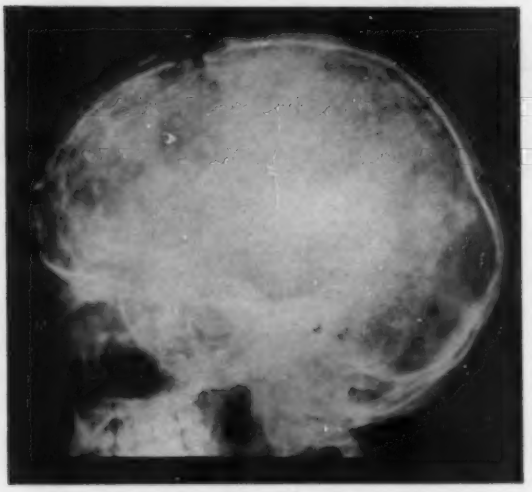

FIG. 1. Case 1. Extensive osteomyelitis of the cranial vault.

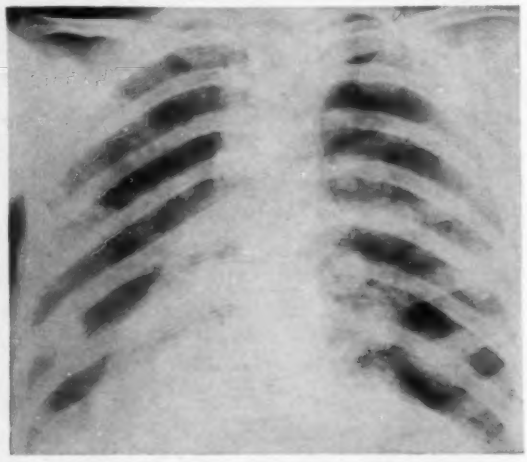

FIG. 2. Case 1. Bilateral sharply defined, round infiltrations at the bases and inner zones.

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both parietal bones (Fig. 1). Roentgenogram of the chest showed numerous round, well defined shadows scattered throughout both lung fields, especially at both bases and in the inner zones (Fig. 2).

After roentgen therapy was given, patient was operated upon, and made an uneventful recovery.

Re-examination of the chest, prior to his dismissal from the hospital, failed to show any evidence of the previously found pulmonary infiltrations.

Case II. V. S., housewife, aged forty-three, entered the University Hospital on July 20, 1936. At time of admission, the patient had a diffuse acute cellulitis of the right side of the face, with collateral edema involving the right supraorbital region and both eyelids. The temperature ranged from 98° to 104° F. The leukocyte count was 24,500. The blood smear showed a marked neutrophilia. *Staphylococcus aureus* was cultured from the exuding pus. On physical examination there was dullness over the left lower lung, râles, and tubular breathing.

Roentgenogram of the chest showed multiple infiltrations scattered throughout both lung fields. They were for the most part well defined,

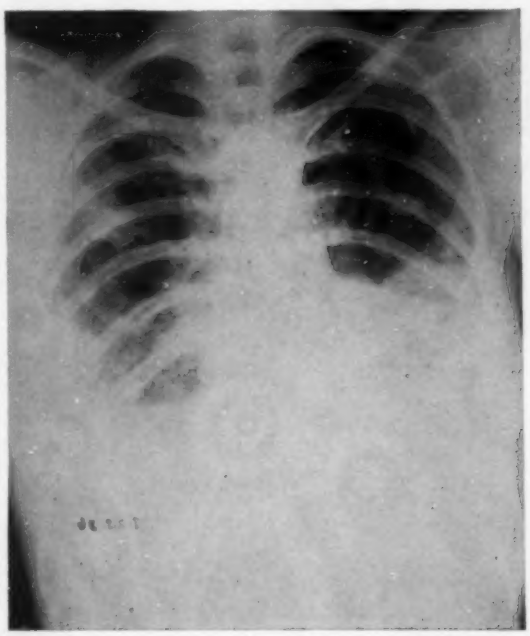

Fig. 3. Case II. Bilateral round infiltrations in lower lung fields. Large infiltration at left base obliterating the costophrenic angle.

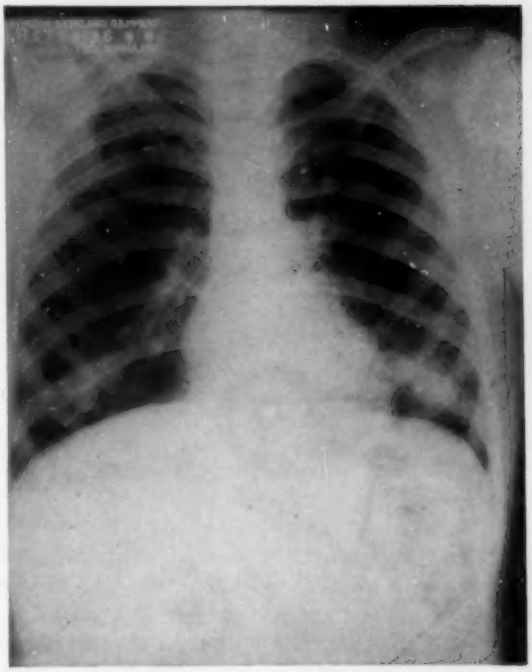

Fig. 4. Case III. Bilateral round infiltrations above the domes of the diaphragm.

sharply outlined, varying in size from 1×1 cm. to 3×3 cm. One large ill defined shadow was present at the left base, obliterating the left costophrenic angle (Fig. 3). Within the course of treatment superficial roentgen irradiation was used. Patient recovered after several weeks.

Re-examination of the chest before dismissal from the hospital showed a residual infiltration at the left base, but the other infiltrations had disappeared.

Case III. L. B., female, aged twelve, entered the University Hospital on August 5, 1936, complaining of pain and swelling of the left knee. These symptoms, of two weeks' duration, were accompanied by intermittent fever. None of the other joints were involved. On physical examination there were swelling, redness, and tenderness of the left knee. The knee was aspirated, and 30 cc. of fluid removed. A culture and guinea pig inoculation failed to demonstrate the pathogenic organism.

Roentgenogram of the chest showed two round shadows, one in each lower lung field, which disappeared after a few weeks (Fig. 4).

Case IV. P. W., male, white, aged thirty-nine, acutely ill, entered the University Hos-

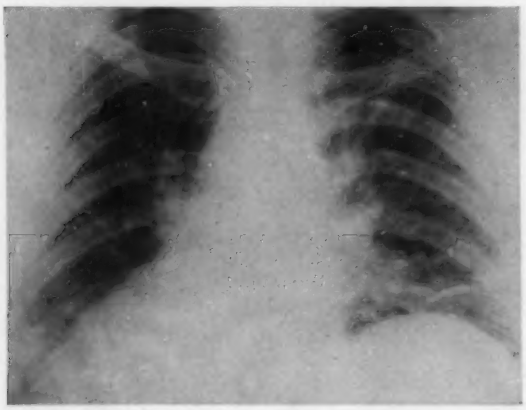

Fig. 5. Case iv. Round infiltration at the right base near the right heart border. Lamellar atelectasis above the right dome of the diaphragm.

pital on November 18, 1936, complaining of severe pain in the umbilical region, which radiated to the right hypogastrium, vomiting, and fever. On examination the temperature was 104° F. There were râles and pleural friction at the right base. Abdomen obese, distended, rigid, and tender, without localized signs. There was active peristalsis. No masses could be palpated. White blood count showed a leukocytosis of 17,000 (82 per cent polymorphonuclears). Clinically the differentiation between an early pneumonia with peritoneal manifestations, and an appendicitis with a possible subdiaphragmatic abscess were considered. Surgery was not considered advisable at this time. The patient was given conservative treatment and kept under close observation. Within the next few days progressive improvement was noted. The abdominal symptoms subsided, pulmonary symptoms had improved.

Roentgenogram of the chest showed a fairly large, round, homogeneous shadow above the right diaphragm dome, and a lamellar atelectasis at the right base (Fig. 5).

Patient returned on December 9, 1936, with identical complaints as on the first entry to the hospital. Appendectomy was performed, and a gangrenous appendix, fixed by adhesions within an inflammatory mass, was removed. Subsequent roentgenograms showed both lung fields to be clear.

Case v. E. B., Negro, aged thirty-seven, entered the University Hospital on May 20, 1937, complaining of pain in the abdomen and vomiting, which contained fecal material. Examination revealed a distended, and tender abdomen. No mass could be palpated. Gastrointestinal series showed evidence of small intestinal obstruction, at the region of the ileocecal valve. At operation a diffuse appendiceal abscess was encountered, which was drained and a colostomy performed. Patient had a fairly uneventful postoperative course until the fourteenth day following operation, at which time, he complained of severe pain in the chest and developed a cough and slight fever. Temperature rose to 104° F. Cough became productive. Bacteriologic examination of the sputum showed presence of spirilla and fusiform bacillus.

Roentgenogram of the chest (Fig. 6) showed a large, round, fairly well defined shadow of homogeneous density at the right base. The right costophrenic angle was free. Diaphragm was fairly movable. Patient expired on October 28, 1937.

On post-mortem examination, a smooth and glistening peritoneum was observed. There was slight scarring of the peritoneum beneath the old surgical incision and the greater omentum was adherent to the scar. The right pleural cavity was filled with 1,800 cc. of thick, brown, foul smelling, purulent fluid, containing many gray friable flakes of fibrin. The left pleural cavity was smooth. There was a small encapsulated abscess between the dome of the diaphragm and the base of the lower lobe. On section, the right lung showed an extensive necrosis and numerous fairly well encapsulated abscesses.

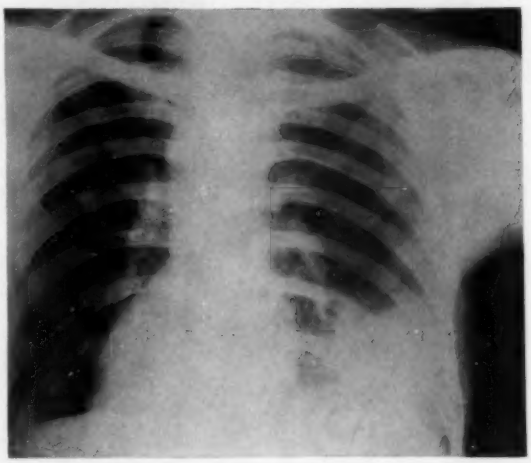

Fig. 6. Case v. Large, well defined infiltration at the right base.

In the above presented group of cases, different organs were affected by an acute inflammatory process that led to suppuration. In the course of the disease the lungs became involved.

Clinically the respiratory symptoms were those of chest pain and cough. On physical examination râles and occasionally dullness on percussion were found. One case developed a pulmonary abscess, complicated by pleural effusion. In 2 cases on physical examination, the clinician was unable to elicit any signs of pulmonary involvement.

Roentgenologically the chest presented single or multiple infiltrations, involving one or both lung fields. These were round foci of various size, with well defined and rather sharp contours. In one case (Case 11) where they were confluent, the characteristic shape and contour were lost. As to their localization, we found them in all cases in the lower lung fields, and near the hila; upper lung fields and apices were not involved. Shadows produced by them were of homogeneous density. They did not show a tendency to increase in size. The resorption of these infiltrations was slow, since they were demonstrable for some time after the primary infection had subsided.

Pathological corroboration of the roentgenological findings in this series of cases was not sufficient to permit a detailed discussion. Since 4 patients made a complete recovery, we had to depend on the pathological findings of only one case, which terminated fatally, and in which a post-mortem examination was performed.

We feel, however, that the changes demonstrated in the lung of this case do justify the opinion that hematogenous metastases from the primary source of infection were responsible for the infiltration which we observed in all of our cases. They represent in our conception, a disseminated embolic pneumonitis or small pulmonary abscesses, which have a great tendency to spontaneous healing. This view seems to be justified because of their form, distribution, and in the majority of instances, multiplicity of the lesion.

A subdiaphragmatic abscess causes, very frequently, secondary pulmonary involvement; and in 2 of our cases, which showed an appendiceal abscess, this complication might have been assumed.

Whereas, in a case of subdiaphragmatic abscess, the pleural reaction is the first to be demonstrable in the form of limitation of motion, and obliteration of the costophrenic angle by sympathetic exudate, the pulmonary changes are somewhat later in appearance, and are most likely the result of a localized atelectasis. Against this, our cases showed neither definite limitation of the mobility of the diaphragm nor obliteration of the costophrenic angle. Their roentgenological appearance differed from that usually encountered in pulmonary atelectasis. The post-mortem examination in Case v failed to reveal a subdiaphragmatic abscess. Multiple, typical, small abscesses were disseminated throughout the right lung. In the remaining cases the multiplicity, the shape, and the localization of the infiltrations, resembling malignant metastasis, indicates even more a hematogenous origin.

It was only where the infection was of mixed type (spirilla and *Bacillus fusiformis*) that the patient developed a true abscess, and succumbed to the infection. The significance of a mixed infection has been well demonstrated by the experimental work of Hedblom, Joannides and Rosenthal.* These authors have proved that the highest percentage of abscesses occurred in dogs which received fresh blood mixed with a sputum containing a high percentage of fusospirochetes mixed with a pyogenic organism. Pyogenic organisms alone did not cause any abscess in the animals. Babes is of the opinion that "these saprophytes cannot of themselves produce gangrene, but are inevitably associated with some other organism, generally pyogenic coccus."

* Hedblom, C., Joannides, M., and Rosenthal, S. Pulmonary abscess; experimental study. *Ann. Surg.*, 1928, *88*, 823–826.

It is important to realize that inflammatory processes can produce, due to the same mechanism of dissemination, embolic pulmonary foci similar to malignant metastasis. Certain pathological conditions of bones offer great difficulty in differentiating between an inflammatory and a neoplastic disease. Suffice it to mention only certain forms of osteogenic sarcoma, or Ewing's tumor, in which the roentgenological differentiation from osteomyelitis is sometimes impossible. In these cases an involvement of the chest might readily lead to an erroneous diagnosis of pulmonary metastasis due to a bone tumor, which as our first case has shown, is not always justified. Then again it will be of considerable value to keep in mind a possibility of metastatic pulmonary abscesses in those cases where the clinical picture is atypical, and presents a definite problem in differentiation between pneumonia simulating abdominal pathology, and a real intra-abdominal suppuration. Pneumonias beginning with symptoms of acute appendicitis are well known and could easily be mistaken when there are no definite pulmonary signs yet detectable. On the other hand, an intra-abdominal suppuration will, in some instances, lead to secondary pulmonary involvement, and physical signs alone might cause an erroneous diagnosis of a pulmonary disease. We feel that a thorough study and clinical analysis will be necessary before the roentgenologist expresses a definite opinion.

CONCLUSIONS

1. Five cases of acute suppurative inflammation of various organs have been reported.

2. The pulmonary infiltrations associated with them have been described.

3. These are thought to be infectious metastases.

4. In common with other inflammatory processes, these infiltrations may resolve with complete restitutio ad integrum of the affected lung parenchyma; their resolution may be delayed, and they are then observed for some time after the primary infection has subsided; or they may form a putrid abscess when associated with an anaerobic microorganism.

5. Their importance in differential diagnosis has been stressed.

Vol. 42, No. 6

METASTASES FROM CARCINOMA OF THE TONGUE*

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CARCINOMA of the tongue is one of the most frequent intraoral neoplasms.[7] General or distant metastases[1,5,8,11] are supposedly quite rare; however, this study indicates a higher incidence than the literature reveals.

Distant metastases of carcinoma of the tongue are not usually thought of when plans are made for the treatment of such lesions. This attitude is largely due to the infrequency of such metastases as reported in the literature. This study indicates that such lesions should be considered an important factor in the conduct of therapy. In fact, the possibility of generalized metastases should be considered as an adequate contraindication to radical neck dissection in most instances and an indication for irradiation of the cervical gland bearing areas.

The relatively small number of published articles on the occurrence of metastases from malignant neoplasms of the tongue have dealt only with extension of the tumor to the regional lymph nodes. For example, Küttner[14] reported that in 117 cases the submaxillary lymph nodes were invaded in 50 cases, the deep cervical nodes in 39, and the submaxillary and deep cervical involvement was present in 25 instances. Duffy[7] in a recent review of 252 cases of neoplasm of the tongue treated at the Memorial Hospital found submaxillary nodal involvement in 18 per cent, deep cervical carotid glands involved in 60 per cent, bilateral metastases in 18 per cent and distant metastases ("clinical findings") in less than 2 per cent.

INCIDENCE OF DISTANT METASTASES

Quick[19] stated as recently as 1934 that, "For many years it has been accepted, without too careful verification, that intraoral carcinoma is practically limited, in its secondary extensions, to the neck. It has been estimated that the incidence of involvement below the clavicle is less than 1 per cent. . . . The figure for distant metastases is undoubtedly much higher." Crile[5] reported an incidence of 1 per cent showing distant metastases in a series of 148 cases of carcinoma of the tongue.

Kaplan[12] in a review of 12 cases of cancer of the tongue found 2 which showed distant metastases. Other than the above, the literature[13,15,23] contains only single case reports of distant metastases without any indication of relative frequency.

Carcinoma of the tongue coincident[10,13,15] with neoplasms elsewhere in the body has been reported. These coincidental lesions have usually been found at some point along the gastrointestinal tract,[10,13,15] although single instances of carcinoma of the tongue in coexistence with a neoplasm of the lung, liver, pancreas, and skin have also been reported.[14,15]

LYMPHATIC DRAINAGE OF THE TONGUE

The lymphatic drainage of the tongue is undoubtedly of primary importance in the metastasis of tongue neoplasms. A brief review of this portion of the lymphatic system is therefore pertinent to this discussion.

Warren[8] divides the main lymph groups as follows:

1. Submaxillary group, lying on the submaxillary salivary gland, drains the border of the tongue as far back as the fauces, the middle section of the anterior half of the tongue, the under surface of the lip, and the floor of the mouth.

2. Superior deep cervical group, lying on the internal jugular vein and carotid, drains all parts of mouth, tongue, fauces and upper part of pharynx. The lymph nodes of the lower end

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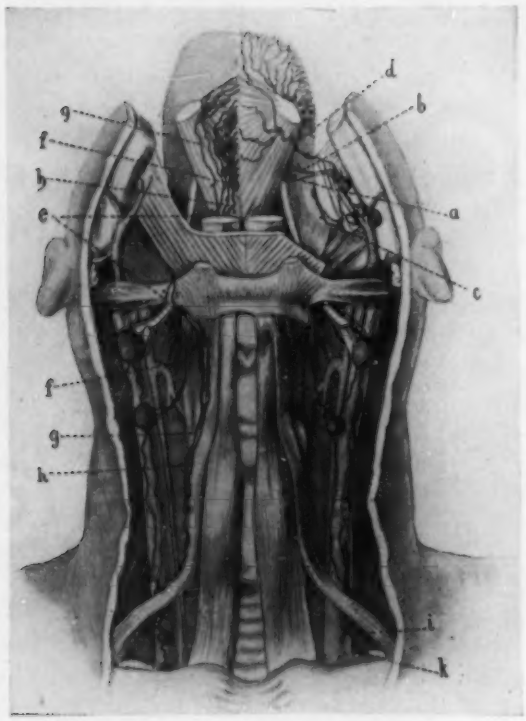

Fig. 1. Lymphatic drainage of tongue (Küttner). *a* and *b*, lymph vessels from anterior and lateral portions of tongue draining into region of submaxillary salivary gland; *c*, lymph vessels from region of plica foliatae draining into the submaxillary lymph gland; *d*, lymph vessels from dorsal portion of the middle third of the tongue and its musculatural draining, partly into the submaxillary lymph gland and partly into the superior and inferior deep cervical lymph nodes; *e* and *f*, superior and inferior deep cervical lymph nodes; *g* and *h*, extension of deep cervical superior and inferior lymph nodes; *i* and *k*, lymph nodes and vessels in supraclavicular fossa.

of the parotid drains the anterior surface of palate.

3. Inferior deep cervical group, lying on the jugular vein and extending down behind the clavicle, drains the apex and base of tongue and the anterior portion of the floor of the mouth. Submental nodes drain lips and anterior portion of buccal floor.

Küttner,[14] in an excellent monograph on the lymph vessel distribution of the tongue (Fig. 1), describes it as follows: The dorsal portion of the tongue has a fine network on the anterior half which increases in size as it goes backward and parallels the papillae circumvallatae. It has side anastomoses with the vessels about the papillae and those of the floor of the mouth in this area. In this area the caliber of the lymphatic vessels is much larger than anteriorly. In back of the papillae circumvallatae the vessels go over to the medial and lateral portions of the tongue, and towards the tonsillar area. Similarly, the lymph vessels on the lateral and inferior portion of the tongue begin in a fine network which increases in size and with frequent anastomoses between itself and the dorsal lymph vessels as it proceeds toward the back of the tongue. It then proceeds in a caudal direction externally to the m. genioglossus and geniohyoid, perforates the m. mylohyoid, and follows the submental artery to end in the submaxillary salivary gland (*a* and *b*). The efferent lymph vessels in the region of the plica foliatae proceed partly on the lateral aspect of the tongue posteriorly and partly underneath the tonsil into the deeper structures to the submaxillary lymph gland (*c*). The lymph vessels, in the dorsal portion of the middle third of the tongue, drain the musculature of the tongue; one branch goes to the submaxillary lymph gland (*d*), the others go to the superior and inferior deep cervical lymph nodes (*e* and *f*), which lie on the jugular vein near the bifurcation of the carotid. The lymph vessels which go to the inferior deep cervical glands (*g* and *h*) proceed under the insertion of the biventer (digastric) muscle next to the major cornu of the hyoid and follow externally to the m. omohyoid until it enters the lymph nodes, which generally lie external to where the m. omohyoid crosses the jugular vein.

The submaxillary lymph gland is a collection of two to four nodes in the loose tissue of the biventer (digastric) triangle formed by the mandible above the m. mylohyoid externally and medially bound by the submental artery. The anterior node lies on the anterior portion of the submaxillary salivary gland. The posterior node lies where the maxillary artery goes over the jaw. They can extend internally until they

are next to the anterior portion of the biventer (digastric) muscle.

The superior deep cervical lymph nodes comprise a chain which lies more often externally to the jugular vein and near the carotid. One of the main lymph nodes which drains the tongue belongs to the above group. It usually lies on the jugular vein at the level of the bifurcation of the carotid, or sometimes, somewhat higher. This chain of nodes (superior deep cervical) can extend in a cranial direction to the base of the skull or caudally, as the inferior deep cervical nodes, into the supraclavicular lymph nodes. Sometimes there may be a few small lymph nodes directly beneath the hyoid.

The inferior deep cervical lymph nodes comprise a chain which lies internally, or externally, to the internal jugular vein where the omohyoid muscle crosses it. From here the lymph chain extends down under the clavicle. The inferior deep cervical nodes communicate with the superior deep cervical nodes above.

Küttner in experimental studies on autopsy specimens observed 2 cases where the deep cervical nodes communicated directly with the thoracic duct; once where it communicated with the subclavian.

There is a small group of lymph nodes which is found in the musculature of the middle third of the dorsal portion of the tongue. They then are seen between both m. genioglossi and communicate with the superior and inferior deep cervical group.

The submental lymph nodes drain the lips and anterior portion of the buccal floor and communicate with the superior and inferior deep cervical lymph nodes. The lymph nodes at the lower pole of the parotid drain the anterior surface of the palate and communicate with the submaxillary and deep cervical lymph nodes.

EVOLUTION OF METASTASES

Carcinoma of the tongue may metastasize by direct extension and by either the lymphogenous or hematogenous route. Starting as a single small lesion, these growths not infrequently spread by direct extension to the floor of the mouth and sometimes to the tonsil, mandible or epiglottis. Tumors in the superficial portions of the tongue do not usually spread across the midline, but in the deeper structures such spread is common,[4] and it is in the latter group that the above enumerated extensions occur.

Most frequently metastasis takes place in the regional cervical lymph nodes. These are involved by embolic spread[1,8] rather than by direct permeation, the intervening tissue being uninvolved. Regional lymph node metastases are said to be accelerated by the contractions of the lingual muscles,[6] thereby forcing the cancer cells along the lymph vessels to healthy areas. The cancer cells may be aided in their extension by an ameboid activity which they have been shown to possess, at least in tissue culture.[16]

Küttner[14] states: "It is not unusual to expect metastasis to the sublingual salivary gland because its position is in direct line with the primary tongue lesion. In addition there is a small lymph node on its medial surface which has direct communication with the lymph vessels at the edge and inferior surface of the tongue. When the submaxillary salivary gland is involved, it is mostly due to its relationship with the submaxillary lymph nodes. If metastases are present in these nodes, they may extend to the salivary gland. There are no lymph nodes present in the submaxillary salivary gland proper; however, lymph nodes are present underneath the capsule and when these nodes are involved with malignant cells they immediately involve the gland proper. Also it is possible to have hematogenous metastasis to the submaxillary salivary gland." In tongue and mouth cancer there is often chronic interstitial inflammation[9] of the salivary glands, with enlargement, suggesting metastasis.

In those instances where the lymph nodes are infected, usually as the result of a badly infected mouth,[19] metastasis is more aggressive. The infected nodes seem

TABLE I

DISTRIBUTION AS TO AGE AND SEX IN COMPARISON WITH MORROW'S RECORDS

	Total No. of Cases	AGES											Male	Female
		30–34	35–39	40–44	45–49	50–54	55–59	60–64	65–69	70–74	75–79	80–84		
Morrow	97	3	7	6	9	15	13	20	11	5	8	0	83	14
San Francisco Hospital	147	1	4	13	23	30	23	24	10	12	5	2	137	10

to have a lowered resistance to the implantation of the cancer cells.

Surgical interference and radium implantation have been alleged to hasten regional and distant metastases.[3,21,24]

Distant metastases may also occur either by lymphatic or hematogenous dissemination, but it is probable that the spread by the latter route is of such rare occurrence as to be relatively insignificant.

SAN FRANCISCO HOSPITAL SURVEY*

One hundred and forty-seven patients with carcinoma of the tongue were treated at the San Francisco County Hospital from 1919 to 1938. The diagnosis of a malignant tumor was made clinically in all cases and confirmed by means of microscopical studies on sections of tissue from the primary growth in 79 cases. The age and sex incidence of these cases is shown in Table I. Morrow's figures are given for comparison.

Symptoms. The most common complaints of the patients here reported were in order of prevalence: Sore on the tongue, localized or radiating pain, difficulty in swallowing, and increasing size of neck (nodal involvement). Rarely, the first complaint of the patient was a mass in the neck[2] in which instances the patient and frequently the attending physician were not aware of the lesion present in the tongue.

The duration of time between noticing one or more of the above symptoms and the date of entering the hospital is given in Table II.

The mean for this series is seven months which corresponds closely to the average of 7.4 months given by Morrow.[17] From this

* These cases have been collected through the courtesy of both the services of the University of California and Stanford Medical Schools, at the San Francisco County Hospital.

TABLE II

DURATION OF SYMPTOMS

Weeks	Number of Cases	Months	Number of Cases	Years	Number of Cases	No History of Duration of Symptoms
						Cases
0–1	2	—	—	1	19	15
2	1	3	15	1½	5	
3	1	4	11	2	3	
4	3	5	9	2½	2	
5	—	6	18	3	3	
6	3	7	13	4– 6	2	
7	—	8	3	8–10	2	
8	8	9	3	11–30	2	
		10	3			

and the fact that the average duration of these lesions and the life expectancy[22] is between one and one and one-half years, it can be seen that many of the lesions had passed through at least one-half of their course before coming in for treatment.

This is corroborated by the observation that at the time the 147 cases of this series were first seen, practically all of them demonstrated an extensive lesion, one-half or more of all the tongue being involved.

metastases are given in Tables III and III-A for the 147 cases surveyed.

All the cases studied showed metastases to the regional lymph nodes at entrance to the hospital or at some time during the period of their stay in the hospital. In most instances more than one group of nodes were involved. However, the submaxillary group was invaded most frequently when the primary growth was either on the tip or lateral border of the tongue; while the

TABLE III

LOCATION OF TUMOR AND ITS METASTASES (REGIONAL)

Location of Lesion	Number of Cases	Pathology	Regional Metastases			
			Submental Lymph Nodes	Submaxillary Lymph Nodes	Upper Deep Cervical Lymph Nodes	Bilateral Lymph Nodes
Tip of tongue	10	Histological evidence of 79 cases was squamous cell carcinoma. No transitional cell type noted	5	9	7	4
Dorsum of tongue	23		4	14	17	9
Lateral border of tongue	47		11	39	34	24
Base of tongue	67		12	53	56	25

TABLE III-A

DISTANT METASTASES AS DISCOVERED BY

Post-Mortem Studies

1. Lungs, pleura, diaphragm, omentum and vertebra
2. Skull, plus regional metastasis
3. Esophagus and retro-esophageal lymph nodes
4. Pleura

Roentgen Studies

1. Lungs (2 cases)
2. Sternum
3. Vertebra

Many of these showed extension to the floor of the mouth. The primary lesion was usually at the base or along the lateral border of the tongue and was either a large solid mass or a large ulcer showing an indurated edge and involvement of the deeper parts of the tongue.

All of the 79 cases, which were studied histologically, were classified as squamous cell carcinoma. The rarities such as transitional cell,[18] basal cell,[1] and lymphoepthelioma[7] types, which have been reported in the literature as arising from the tongue, were not found in this series. The site of the primary lesions and the sites of upper deep cervical group was the site of predilection for metastases from the dorsum and base of the tongue.

Four coincidental carcinomas were found in this series. Two were found in the stomach, one in the breast and one in the skin (basal cell carcinoma of the nose). In no instance were these distant metastases from the tongue.

Distant Metastases. Distant metastases were found in 4 cases by roentgenological studies and in 4 other cases by post-mortem studies. The incidence, on a basis of 8 cases showing distant metastases out of 147 cases treated, is equal to 5.4 per cent; while, on

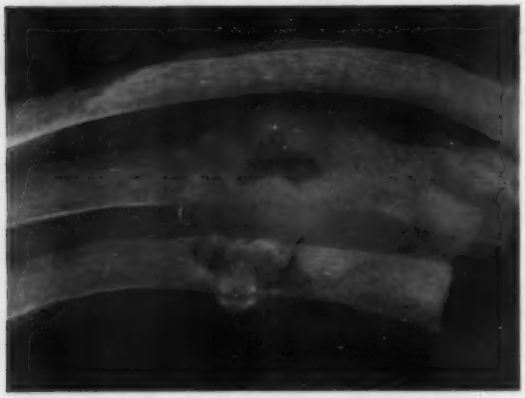

FIG. 2. Case 1. Post-mortem roentgenogram showing destruction of ribs.

a basis of 4 cases out of 41 cases autopsied, the incidence is 9.7 per cent. Undoubtedly, the incidence is higher than previously reported figures of 1 or 2 per cent, and when treatment is not instituted before the lesions are far advanced, as in this series, a 9.7 per cent incidence seems a much more probable figure.

CASE REPORTS

The 4 cases showing distant metastases by post-mortem studies are here reported.

CASE 1 (No. D186446). J. W., male, aged sixty-one, German elevator operator, was treated for lues in 1931 and 1932. During this time he had various leukoplakic areas on the dorsum of the tongue which would recede and recur under local treatment. In October, 1936 an irregular, hard nodule, 2 cm. in diameter, was seen on the right posterior dorso-lateral surface of the tongue; no cervical adenopathy present. Antiluetic therapy administered. Since no change was noted after one month, six gold radon seeds (filtration 0.5 mm. gold) were inserted into the lesion for a total dose of 1,915 mc-hr. The patient was symptom free until July, 1927, when a node 3 cm. in diameter was noted adjacent to the angle of the right mandible. From July 27 to August 18, 1937, he received 200 r (on alternate days) to the right side of his neck; 200 kv., 60 cm. distance, 0.5 mm. Cu and 1 mm. Al, 10 cm. diameter circular field, which was later reduced to 5 cm. for a total dose of 2,000 r. The node in the neck disappeared. The patient was symptom free until November 23, 1937, when he complained of abdominal pain, more marked in the epigastric area, and urinary incontinence.

Physical examination in November, 1937 showed the tongue to be scarred in the mid-portion; firm, though not indurated or fixed. There were a few hard nodes at the right angle of the mandible. No other glands were felt. There was a loss of sensation to pin prick below the umbilicus and motor paralysis of the legs as well as loss of urinary and rectal control. There was a depression in the region of the eighth dorsal vertebrae. The Kahn test was 3 plus.

Roentgen Examination. Destruction and partial collapse of the eighth dorsal vertebrae (Figs. 2 and 3), massive pleural effusion on the right with metastases to the ribs; six radon seeds in the region of the tongue.

Course. The patient became stuporous; died in uremic coma four days after admission.

Autopsy Report. Examination of the mouth revealed a depressed 2 cm. area of cicatrization in the mid-portion of the right side of the tongue. There were two shotty nodes deep in the right side of the neck, one at the angle of the mandible and the other lower down. Several gold radon seeds were deeply embedded in the scar of the tongue. A firm, white node (1

FIG. 3. Case 1. Post-mortem roentgenogram showing destruction and collapse of the eighth dorsal vertebra.

cm. in diameter) was noted at the angle of the mandible and a larger node was attached to the lateral border of the right sternocleidomastoid muscle. The salivary glands beneath the right mandible were more firm than usual.

Several firm, pearl-white nodules, averaging 1 cm. in diameter, were found in the anterior mediastinum. The right pleural cavity contained a liter of thin, clear, yellow fluid. There were adhesions between the right lung and tumor nodules in the fourth and seventh ribs and over the diaphragm. The right peribronchial lymph nodes were enlarged, matted together, and largely replaced by tumor, which diffusely extended into the middle lobe of the lung along the main bronchus. The lungs contained patches of bronchopneumonia.

The omentum contained a number of firm white tumor nodules up to 1 cm. in diameter.

The body of the eighth thoracic vertebra was soft and compressed to a third of the thickness of the others. It was displaced posteriorly causing pressure on the spinal cord.

Histologic Examination. The tongue was covered by a thin layer of squamous epithelium. Hyalinized fibrous tissue with areas of mucoid degeneration extended irregularly into and replaced some of the muscle beneath. No epithelial tumor was demonstrated. Sections of the lymph nodes of the deep cervical chain on the right (Fig. 4) showed the lymphoid tissue almost completely replaced by sheets of atypical epithelial cells varying considerably in size and staining quality; mitoses were numerous; there was marked keratinization. The mediastinal, omental, pleural and peribronchial nodules presented a similar picture. The right salivary glands and the hilar area of the middle lobe of the right lung were also infiltrated with similar epithelial tumor with pearl formation. Sections of the ribs and vertebra did not show tumor but this was undoubtedly due to the fact that the blocks were not taken from the proper areas.

Pathological Diagnosis. Carcinoma of the tongue with generalized metastasis including the lungs, ribs, pleura, omentum and vertebra. Primary lesion not seen at the time of autopsy.

Case II (No. D124091). J. K., male, white, aged fifty-eight, sailor, admitted December 21, 1932. He complained of a sore throat, pain on the right side of the neck and difficulty in swallowing for seven months.

Examination revealed an ulcerated lesion 2.5×1.5 cm. surrounded by a raised edge at the

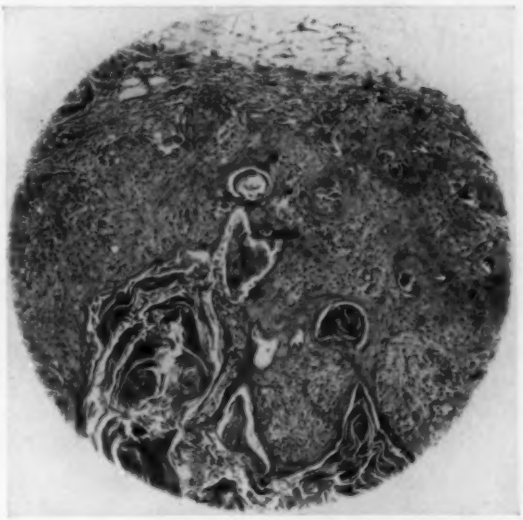

Fig. 4. Photomicrograph of section from a deep cervical lymph node showing sheets of atypical squamous epithelial cells with marked keratinization (×70).

right base of the tongue. The tongue was fixed. There were hard lymph nodes along the upper anterior edge of the right sternocleidomastoid muscle. Roentgenograms of chest, skull and spine were negative for metastases.

Radiation Therapy. January 1, 1933, to March 3, 1933, 200 r daily, 200 kv., 2.2 mm. Cu plus 1 mm. Al filtration, 10 cm. square field for a total dose of 3,965 r to right and left upper neck. From May 11, 1933, to May 19, 1933, 100 r daily was given, tin filter, for a dose of 600 r to right side of face.

Examination on May 9, 1933, revealed that the tongue was not as fixed as formerly and the cervical nodes were smaller, but the local lesion was essentially the same. Examination one week later showed the lesion extended to the right tonsil and base of anterior pillar. The epiglottis was edematous. On June 16, 1933, the ninth nerve was cut for the relief of pain. The patient died two days later.

Roentgenogram (post mortem) of chest was negative for metastases.

Autopsy Findings. Gross: An irregular palpable ulcer, 3 cm. in diameter, was found on the base of the tongue extending to the right tonsil. Half of the tongue was infiltrated. There were apical scars and adhesions between the lobes of the left lung and at the apex. Small grayish nodules were scattered throughout the right pleura. The right pleural cavity was large-

ly obliterated by fibrous adhesions. The remaining organs were negative for metastases.

Microscopic: Tongue: A moderately fibrous reticulum supported irregular masses of large atypical epithelial cells. The nuclei were irregular, many mitotic figures were present plus pearl formation. There were small areas of necrosis present probably due to radiation reaction. Tumor cells extended into the muscle of the tongue and filled the neighboring lymphatic vessels. Pleura: Thickened with groups of epithelial tumor cells plus round cell and large mononuclear cell infiltration. Cervical lymph node: Hyperplasia but no evidence of tumor cells.

Pathological Diagnosis. Carcinoma of the tongue with metastases to the pleurae.

CASE III (No. D137307). N. B., male, white, aged sixty, admitted to the hospital January 30, 1934, with a history of difficulty in swallowing and pain in the throat for a duration of seven months. Examination December, 1933, in the outpatient clinic, revealed a lesion involving the base of the tongue on the left. The left submaxillary nodes were palpable. Bilateral hyoid nodes were present and the left sternocleidomastoid nodes were involved. Biopsy of the tongue showed a squamous cell carcinoma rich in mitoses with no cornification.

Roentgenogram of chest, December 28, 1933, was negative.

Roentgen therapy to tongue and neck from December 28, 1933, to February 2, 1934, was administered with the following factors: 200 kv., 50 cm. target-skin distance, Thoraeus filter, 10 × 14 cm. field, equal to a total of 3,000 r. The fields included the neck, the angle of the mandible, and the base of the tongue.

The patient re-entered the hospital in 1934 because of difficulty in swallowing. Examination at this time failed to reveal a lesion of the tongue; no nodes could be palpated in the neck.

Roentgenogram of esophagus, March 15, 1934, revealed a carcinoma of the middle third.

Esophagoscopy on April 19, 1934, revealed a bulging on the lateral wall below the cricopharyngeal structure. Twenty-seven centimeters from the incisura, an ulcerated, irregular tumor involving the anterior and lateral wall could be seen. Biopsy of the esophagus revealed a squamous cell carcinoma. The patient died of bronchopneumonia on June 18, 1934.

Autopsy Findings. There were no visible or palpable lesions on the tongue, in the mouth or in the neck. Dissection of this area was not permitted. In the esophagus beginning 8 cm. above the cardia and extending 7 cm. upward was a flat soft tumorous area with a necrotic ulcerated center. The lymph nodes near this area appeared normal. No tumor was found in the other organs. *Histology:* Esophagus: The mucosa was ulcerated away leaving necrotic submucosal tissue forming the surface. In this and scattered through the muscular wall were round and oval islands of closely packed squamous type of epithelial cells presenting a picture quite similar to that seen in the biopsy of the tongue. Tumor was more plentiful deep in the muscle and in the loose tissue beyond than in the submucosa. Much of the tumor appeared to be in dilated lymphatics. The larger areas showed central necrosis but no cornification. Lymph node, retro-esophageal: Approximately half of the lymphoid tissue was replaced by a large area of epithelial tumor with necrotic center and fibrous tissue in the periphery.

Pathological Diagnosis. Carcinoma of the tongue with metastases to the retro-esophageal lymph nodes and the esophagus.

CASE IV (No. 112853, D714666). D. S., male, white, aged forty-two, was admitted July 6, 1928. In April, 1927, the patient first noticed that his tongue was sore and he complained of pain in both jaws.

Examination three weeks later revealed a small ulcerated lesion 2.5 × 0.75 cm. on the left lateral posterior aspect of the tongue. No nodes were felt in the neck. Biopsy of the tongue lesion revealed squamous cell carcinoma.

Seven gold radon seeds (totaling 15 mc.) with 0.3 mm. gold filtration were inserted into the lesion (1,895 mc-hr.). One month after the radon was given a partial resection of the left cervical lymph nodes was done. In December, 1927, the neck again became painful, and the remaining left cervical nodes were removed. Seven weeks later the posterior side of the left neck became tender. He had difficulty in swallowing and became hoarse.

Examination revealed a small raised nodule 1 × 1 cm. on the distal third of the left side of the tongue. Operative scars were noted in the left cervical region. Roentgenogram of the chest July 9, 1928, was negative. Bronchoscopy July 13, 1928, was negative. On July 16, 1928, there was a sudden swelling over the left mandible and parotid area which produced Bell's palsy. Roentgenogram on July 20, 1928, revealed

some delay in passage of barium at the upper third of the esophagus due to an extrinsic mass. The patient failed rapidly and died July 28, 1928.

Post-Mortem Findings. A firm mass was felt beneath the left ear and mandible. Larynx and tongue revealed no discernible lesion on the surface of the tongue. A small radon seed was found 7 cm. from the tip of the tongue on the left side. Another radon seed was found posterior to the first one. There was translucent white tissue surrounding these seeds which appeared to be scar or neoplastic tissue. The lateral posterior border of the tongue was indurated. The dura over the petrous portion of the left temporal bone was slightly injected. A large part of the petrous portion of the bone was necrotic. This necrosis extended over to the adjacent base of the skull and destroyed the styloid process. There was a defect 2 cm. in diameter in the bone when the necrotic portion was removed. This was the area through which the clinically involved nerves emerged from the skull.

Histology. There was considerable fibrosis of the tongue. The serous and mucous glands were destroyed, apparently by radiation. No tumor cells were found.

The mass in the left neck revealed epidermoid carcinoma with pearl formation. The tissue at the base of the skull also revealed epidermoid carcinoma. The tissue from the petrous portion revealed bone destruction replaced by epidermoid carcinoma and fibrous tissue. Occasional spicules were present. The remaining organs were negative for metastases.

Pathological Diagnosis. Carcinoma of the tongue, adult type, with left regional lymph node metastases plus extension by lymphatic route to the base of skull involving the petrous bone.

SUMMARY

1. The location of regional and distant metastases in 147 cases of primary carcinoma of the tongue has been briefly reviewed and summarized in table form.

2. The proportion of male to female was fourteen to one.

3. The average age was between forty-five and sixty-five years.

4. The mean average duration of symptoms before seeking medical aid was seven months. Over 50 per cent of this group gave a history of duration of symptoms ranging from two to seven months. The shortest was four days, the longest thirty years.

5. Four (9.7 per cent) of forty-one autopsied cases had distant metastases; 5.4 per cent on a basis of eight out of 147 cases.

6. Two of the autopsied cases failed to reveal any evidence of malignancy in the tongue after interstitial radium therapy. The cause of death was due to distant metastases and intercurrent disease.

7. The review of the lymphatic distribution of the tongue and neck offers a plausible explanation for the occurrence of distant metastases.

8. Though transitional cell carcinomas of the tongue are more apt to produce distant metastases than the squamous cell type, they are infrequent. No transitional cell carcinomas were present in this group of cases.

CONCLUSIONS

Of 147 cases of primary carcinoma of the tongue, forty-one of which were autopsied, four cases had distant metastases. Four additional cases had roentgen evidence of distant metastasis—two to the lungs, one to the sternum, and one to a vertebra.

If one is to seriously consider any future therapy whether it be surgery, radium, or roentgen therapy, or any combination of the three, then, in view of the above findings it would seem prudent to keep in mind the frequent possibility of distant metastases.

I wish to express my thanks to Drs. Harold A. Hill and James B. McNaught of the Departments of Radiology and Pathology at the Stanford University Medical School, for their help and criticism in preparing this article.

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Vol. 42, No. 6

SPONTANEOUS AMPUTATION OF THE TONGUE

CASE REPORT

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SPONTANEOUS amputation of the tongue, partial or complete, is a very rare occurrence. Butlin[1] states that more or less complete loss of the tongue secondary to gangrene or large mercury dosage over a long period of time was not so uncommon in the days when smallpox was prevalent and when control of mercury dosage was much less accurate than it is today. Any acute or chronic infection of the tongue can apparently result in its amputation. Bozo[2] says that the general form of the tongue, plus its rich vascularity, the absence of hard parts, and the compressive action of the teeth favor singularly the typical progress of these lesions (gangrene, etc.); and that one can understand upon considering its structure why the different ulcerative processes which may affect it progress so rapidly to partial or complete amputation. He added that amputation can be complete or incomplete; that is, the anterior portion, isolated from the remainder of the organ by the ulceration, may become detached completely or remain attached by a small isthmus of substance. With the earlier diagnosis and treatment of malignant neoplasms of the tongue, ulceration usually does not proceed far enough to isolate a portion of the tongue and so cause its expulsion.

The phenomenal case mentioned by Fitzwilliams[3] in which a woman in a fit of hysteria just reached into her mouth and pulled out her tongue is unique.

According to Bozo there is always a deep ulceration which is the first phase of the amputation of the tongue. The portion of the organ distal to the ulceration is thus gradually deprived of its blood supply and finally sloughs off. The case presented by Bozo was one in which a carcinoma of the floor of the mouth pushed the tongue from the oral cavity while invading it. Little by little the tongue was being divided from its insertion at the floor of the mouth by pressure of the teeth until it was hanging outside of the mouth.

CASE REPORT

White male, aged fifty-six, first seen on April 27, 1934. Patient complained of tumor on the tongue, bleeding from mouth, and pain upon swallowing, all of six weeks' duration. Examination revealed a well-nourished person in apparently good physical condition. There was no evidence of recent loss of any great amount of weight. The mouth could not be opened wide due to pain.

FIG. 1. Bulging tumor on dorsum of tongue can be clearly seen. Tongue could not be extended beyond incisor teeth. Mouth could not be opened wide due to marked pain.

Local condition: Beginning at a point about 3 cm. posterior to the tip of the tongue was a very hard, elevated mass producing a bulge of practically the entire remainder of the tongue (Fig. 1). The borders of this mass were very firm and along the posterior portion of the left side of this mass was a large indurated crater.

Fig. 2. Film taken on the day following the radium implantation into the tongue. Radium needles and gold seeds are seen *in situ*. The dense homogeneous mass of the tongue displacing the hyoid bone downward is demonstrated. The depth of the mass may be gauged from the fact that the 35 mm. length needles inserted perpendicularly into the tongue occupy only one-half of the extent of the tumor.

This crater bled easily when touched. The left tonsillar fossa was transformed into an ulcerated mass which extended along the soft palate anteriorly to involve the posterior portion of the hard palate along its alveolar margin. A small, hard nodule was felt along the left buccal mucosa near the ramus of the mandible. The region between the body of the left mandible and the tongue was firmly indurated. An infiltration was felt in the left submandibular region but no individual lymph nodes could be made out.

Blood Wassermann reaction was reported negative. Biopsy of edge of ulceration on left side of the tongue showed "epidermoid carcinoma (moderately differentiated)." Roentgen examination of the chest revealed no abnormal shadows. Roentgen study of the neck on May 14, 1934, disclosed the presence of a dense shadow in the submandibular and sublingual regions. There was no involvement of either mandible as far as could be determined from the roentgenograms of these parts.

There was a slight delay before the institution of radiation therapy while waiting for healing to take place at the sites of extracted teeth. When roentgen therapy was begun on May 14, 1934, several firm lymph nodes were palpated in the left submandibular region. Radiation therapy was continued until June 11, 1934. The following physical factors were employed: 200,000 volts, 4 ma. 2 mm. copper plus 1 mm. aluminum filter, and 50 cm. target-skin distance. The size of the fields varied from 10 by 10 cm. to 10 by 15 cm. Treatment was given twice daily, morning and afternoon, 150 r (measured in air) being administered at each session. The left side of the neck, anterior, posterior and lateral, received 3,150 r; the right lateral neck 1,900 r; and the submental area 700 r. This made a total of 5,750 r, divided over the above mentioned fields, treatment being given daily except Sundays.

Nine days after treatment was begun the patient felt much better and could open his mouth wider. On the fourteenth day of treatment a beginning mucositis was noted over the uvula as well as over the ramus of the left

Fig. 3 Film taken on December 19, 1934, two days after the amputation of the tongue occurred. The hyoid bone is now higher in position as compared with Figure 2. The mass previously demonstrated in the posterior portion of tongue is no longer present. The triangular defect in the tongue is part of area formerly occupied by neoplasm.

mandible. The mucositis healed completely thirty days after the first treatment. A dry dermatitis was noted on the twenty-seventh day of treatment, over the left side of the neck, and lasted for eleven days. The neoplasm in all its extension, except on the tongue proper, completely disappeared about one month after roentgen therapy was begun. The infiltration in the tongue, although smaller, was still definitely present at this time. On June 27, 1934, radium element needles and gold radon seeds were implanted into and around the infiltration in the tongue. Of the former, three needles, 2 mg. in strength, 35 mm. long and filtered with 0.5 mm. platinum, were left *in situ* for a period of five days; of the latter, six gold seeds (0.3 mm. filter), containing 1 mc. radon, were inserted permanently for a dose of 800 mc-hr. The extent of the tumor at the time of the radium implantation is very graphically demonstrated in Figure 2. The tumor of the tongue regressed further but a great deal of neoplasm still remained two months after radium therapy.

On August 25, 1934, two months after the insertion of the radium into the tongue, the patient had several profuse hemorrhages from the mouth. The left external carotid artery was ligated on the same day. The hemorrhage was controlled. Five days later, a foul odor was noted in mouth despite frequent irrigations. Speech was thick and swallowing was painful and difficult. Ulceration on left posterior portion of tongue was covered with white exudate. The lymph nodes in left neck were firm. The patient's condition remained stationary until December 10, 1934, when a piece of necrotic tissue measuring 3 by 1 by 1 cm. was removed from the left posterior portion of the tongue. The tongue had a brownish-green discoloration and a gangrenous odor exuded from the oral cavity. Four days later the whole tongue was soft and fluid-like, and it was apparent that it was sloughing out. This actually occurred three days later, leaving an irregular necrotic area on the floor of the mouth with a very small portion of tongue protruding in its right posterior region (Figs. 3 and 4). The extruded tongue measured 6.5 by 2.5 cm. (Fig. 5). Speech, though impaired, could be fairly well made out. The neoplasm on the soft palate now showed evidence of recurrence and grew very rapidly. Patient's condition gradually declined and death ensued on January 30, 1935.

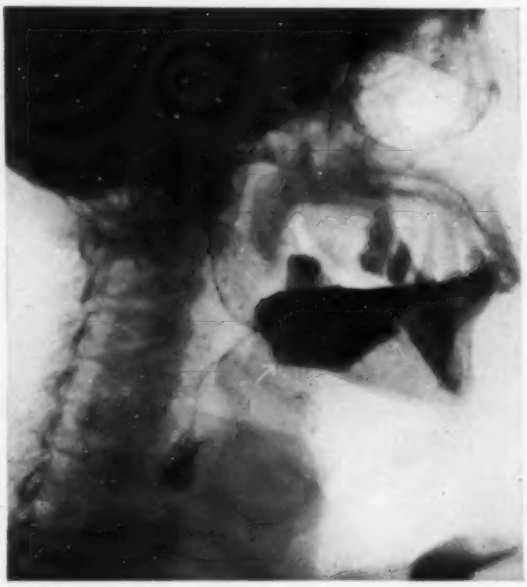

Fig. 4. Defect in tongue outlined with the aid of barium.

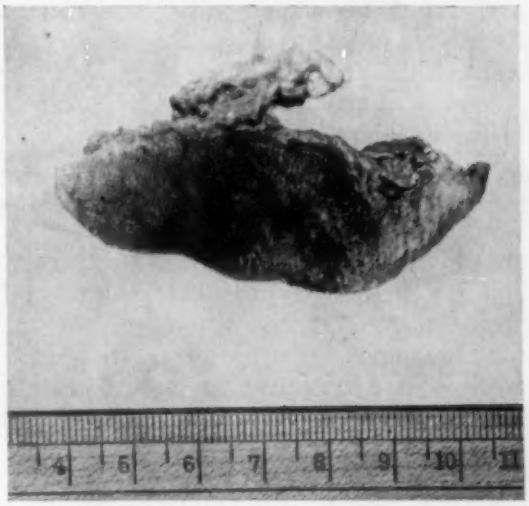

Fig. 5. Specimen of tongue which was extruded from mouth. Measurements are those after fixation of specimen in formalin. Histological examination revealed both degenerated muscle fibers and carcinoma cells.

DISCUSSION

A case of spontaneous amputation of the greater portion of the tongue is presented. The patient had a very extensive carcinoma involving the major area of the tongue

and infiltrating deep into its muscles. Roentgen, and interstitial radium therapy were administered resulting in a temporary recession of the new growth. Recurrence of the neoplasm, however, advanced very rapidly. Severe hemorrhage from the ulcerated portion of the tumor necessitated ligation of the external carotid artery on one side. What part the radiation therapy and the ligation of the external carotid artery played in the separation of the tongue cannot be definitely stated. It is possible that the carcinomatous ulceration itself may have resulted in the spontaneous amputation (case cited by Bozo). The fibrosis and vascular thrombosis secondary to the irradiation and the relative ischemia due to the blood vessel ligation may have accelerated or may even possibly have brought about the unusual occurrence.

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ROENTGEN PELVIMETRY

A SIMPLIFIED METHOD*

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THE method of measuring the internal diameters of the female pelvis by means of roentgenograms as described in this article is intended to provide a simple procedure not requiring unusual apparatus for the production of the films or their interpretation. The films are made with the patient in the ordinary supine position and yet show a true representation of the pelvic inlet comparable to that obtained by the method of Thoms.[4] The technique of making these films is not difficult, the measurements can be made rapidly, and the values of the internal diameters are of a degree of accuracy comparable to those obtained by some of the more complicated methods now in use.

The films taken consist of two anteroposterior and one lateral film. The anteroposterior film of the inlet is taken first. The tube is adjusted so that the focal spot is 30 inches above the film in a direct vertical measurement, and it is so used in all the three films. The patient is in the supine position and the tube is set so that the central ray, as judged by whichever method of determination is convenient, passes through the pelvis at an angle of 12.5 degrees toward the feet of the patient from the vertical, and just slightly to the feet with respect to the anterior superior spine of the ilium. The cassette holder and Potter-Bucky diaphragm underneath the table are moved far enough to the foot of the table to include the symphysis pubis on the film. The second film, a view of the subpubic arch, is taken with the central ray directed 20 degrees cephalad from the vertical. If the fetal head is not in the pelvis, a film of the abdomen to demonstrate the fetal head is made with the rays passing perpendicular to the film. For the lateral film the patient is placed with the right side down and the legs and body as nearly as possible in alignment with the

FIG. 1. Measurement of the lateral film.

lines of the table. A pillow is placed under the right side to make the lumbar spine parallel with the table and film in order that the mid-sagittal plane of the pelvis shall be parallel to the film. If the same side is always placed down in making the lateral views it simplifies the cephalometry.

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The technician measures the bitrochanteric diameter in centimeters and records it.

To determine the dimensions of the pelvis from the films one starts with the lateral film and marks it as indicated in Figure 1. A line is first drawn 1 cm. behind the sacrum as illustrated. As this line is 1 cm. behind the sacrum on the film it represents a point approximately 0.7 cm. behind the sacrum in space. This line parallel to the longitudinal axis of the patient is to represent the table top at the time the anteroposterior view is made. After the position of the obstetrical conjugate, which is defined as the shortest distance from the inner side of the symphysis pubis to the nearest point of the sacrum in the superior strait, is located, a line is drawn through it. A line representing the longitudinal axis of the body is drawn so as to intersect the posterior end of this conjugate.

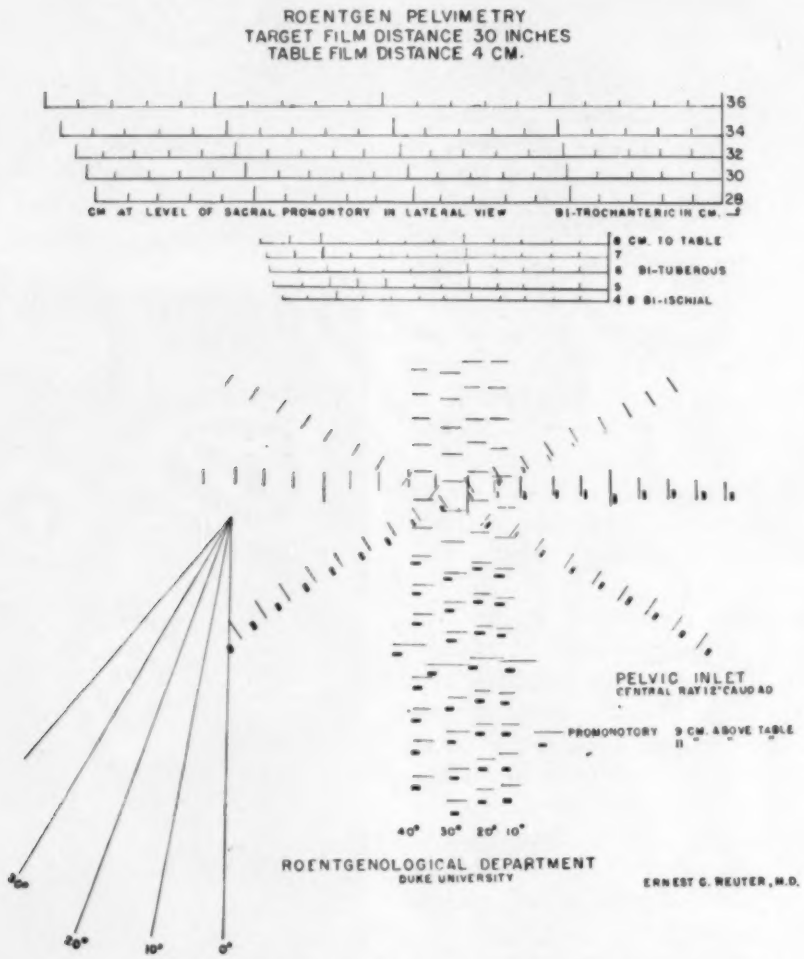

FIG. 2. Scale for the measurement of films. Original reduced one-third. Based on a chart of Walton.[5]

The films are made with a target to film distance of 30 inches because Walton[5] has constructed a scale for fetal cephalometry based on this distance. The principle of Walton's chart is that for each centimeter of height above the film there is what has been termed a false centimeter scale showing the amount any length up to 20 cm. would be enlarged on the film if the distance casting the shadow were parallel to

the film at the distance above the film for which the particular scale is intended to apply, and if the central ray passes approximately through the center of this distance at a target to film distance of 30 inches. If the height of any distance parallel to the film is known, one may apply the scale pertaining to this height to the shadow cast on the film and obtain by means of the enlarged centimeters on the scale a reading of the original distance in true centimeters.

The scales of that portion of the transparency shown in Figure 2 which are for the purpose of measuring dimensions in the mid-sagittal plane of the patient as seen in the lateral film are based on this chart of Walton's. The mid-sagittal plane should be half way between the two greater trochanters of the femora. Inspection of the anteroposterior view of the pelvis will show whether any given case has the greatest anteroposterior dimensions of the inlet essentially midway between these greater trochanters. If so, the anteroposterior conjugates are half of the bitrochanteric diameter off of the table when the lateral view is made. If the film to table distance is added to half of the bitrochanteric diameter, the distance the obstetrical conjugate is from the film at the time of making the lateral film is obtained. The following example will illustrate this:

Bitrochanteric	=32 cm.
Table to film	= 4 cm.
32/2+4	=20 cm.

Thus in this instance, distances in the mid-sagittal plane can be measured on the lateral film by using that level of Walton's chart intended for correction of distortion caused by the dimension casting the shadow being 20 cm. above the film. It is this scale which has been used as the third line from the top and marked 32 at the right in the first set of scales as shown in Figure 2. The scales for reading dimensions off lateral films pertaining to patients with other bitrochanteric diameters have been derived from this chart of Walton's by the same method as shown above.

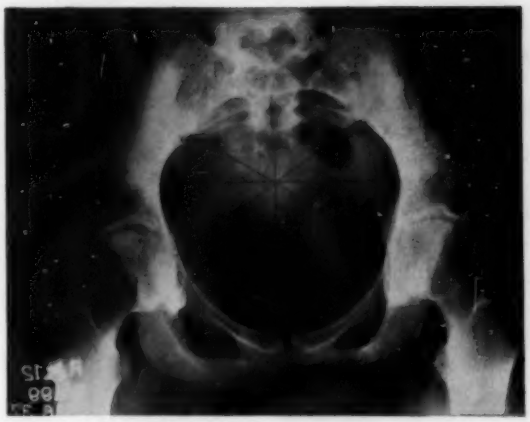

Fig. 3. View of inlet taken with patient supine.

As the scales are on a transparency they may be applied directly to the film to be measured. The scale marked with the patient's bitrochanteric diameter, which is used to measure the obstetrical conjugate, is also used to note the distance the posterior limit of the inlet is from the line which represents the table at the time of making the anteroposterior film of the inlet, as shown in Figure 1. The distance of the ischial spines from this line is also noted with the same scale. If the two spines do not coincide, as is the case in the illustration, one can take a point between them. All other dimensions in the mid-sagittal plane such as those pertaining to the depth of the sacrum and the anteroposterior diameter of the outlet can be measured with the same scale if the limits of the diameters can be visualized on the film. The angle the plane of the inlet makes with the longitudinal axis of the body, which should be parallel with the edges of the film, is also noted with the protractor on the transparency. Comparison of lateral films made while the patient is in the supine position with lateral films made while the patient is on the side show only a few degrees' difference in this angle in 10 cases.

The measurement of the anteroposterior view of the inlet, as seen in Figure 3, and with the scales applied as in Figure 6, is made by using whichever pattern of anteroposterior scales of the lower right of

the transparency of Figure 2 applies most closely to the case under consideration. There are two patterns of these scales for the anteroposterior, transverse, and oblique diameters. One is for use when the distance from the posterior limit of the inlet at the promontory of the sacrum to the line drawn behind the sacrum on the lateral view is 9 cm. when measured with the scale marked with the patient's bitrochanteric diameter. The other set is for use when this distance is nearer 11 cm. In the case used for Figure 1 the posterior limit of the inlet was 8 cm. from the table top when the anteroposterior film was made. The set of scales marked "promontory 9 cm. above table," is therefore used for the measurement of the diameters of the inlet in this instance. This means that in this particular case one would read between the long lines on the transparency and disregard the short heavy ones. The value for the obstetrical conjugate or anteroposterior diameter in centimeters should be read off the scale marked with the degrees most closely corresponding to the angle of inclination of the plane of the inlet with the longitudinal axis of the body as determined from the lateral view. The degrees for which each of the four anteroposterior scales apply are marked at the lower or anterior end of the scales. The upper end is intended to be applied at the sacral promontory. There frequently is a difference between the value read for the anteroposterior diameter from the lateral plate and the value of this same diameter as determined from the anteroposterior plate. This difference may be as much as 5 mm. In such instances it is customary to report an average of the two readings unless there is reason to think that one is more accurate than the other.

The scales for the measurement of the diameters of the inlet on the anteroposterior film are derived from the roentgenography of a model which was constructed in the following manner. The anteroposterior diameter of the pelvis was represented by four scales consisting of radiopaque markers at 1 cm. intervals. These scales were set at inclinations of 10, 20, 30, and 40 degrees with reference to the table top and film. The posterior ends of the scales, supposedly representing the promontory of the sacrum, were fixed at 9 cm. above the table top. The scale for the greatest transverse diameter of the inlet was placed 8 cm. above the table. While this may be too low for some cases, examination of cadavers and lateral films of pelvis shows that this transverse diameter of the inlet is always definitely below the anteroposterior diameter and that it may be below the promontory of the sacrum in some cases. The inlet therefore should not be treated as having all diameters on one plane. Two scales to represent the oblique diameters of the inlet were placed on the plane of the anteroposterior scale with the 30 degree inclination.

Examination of patients in the supine position gives the impression that the part of the pelvis which rests on the table is the posterior aspect of the distal part of the sacrum. Lateral roentgenograms with the patient in this position show this to be true. It does not appear to be of consequence whether the patient is extremely thin or extremely heavy, or is of average weight, for there is never much tissue posteriorly over the sacrum. It is valid therefore to use the line drawn behind the sacrum as in Figure 1 to represent the table top. Studies of lateral films of the pelvis by means of this method show that the distance from the posterior limit of the inlet to a plane behind the sacrum representing the table surface on which the patient is recumbent when the anteroposterior film is made is not less than 8 cm., not over 11.5 cm., and usually about 8.5 or 9.0 cm. in a series of 60 cases.

The distance between the ischial spines is determined from the anteroposterior film of the inlet by first noting the distance they were from the table at the time of making this film, as already explained in connection with the measuring of the lateral film. Of the second set of scales on

the transparency which are marked "bituberous and bi-ischial," the one for the height the ischial spines are above the table is applied to the film of the inlet for the reading. The same principles may be used in measuring the bituberous diameter on the film of the subpubic arch but it is not usually possible to measure it to the same degree of accuracy because it may be difficult to define the limits of this diameter even on a very good film.

The values given for the superior strait of the female pelvis by Williams[6] are, transverse diameter 13.5 cm., and obstetrical conjugate 10.7 cm. The enlargement of 13 cm. of the transverse diameter scale is 15.5 cm. as actually measured on the film. To ascertain the amount of obstetrical conjugate should be enlarged in order that this enlargement should be proportionate to that of the transverse diameter, the following ratio is used.

$$13.0:15.5::11.0:x$$
$$x=13.1$$

Most female pelves appear to be inclined at some value near either 20 or 30 degrees with the horizontal plane when the patient is supine. The value of 13.1 cm. for the enlargement of the anteroposterior diameter is most nearly obtained at 10 degrees' deviation of the central ray from the vertical toward the feet for inlets of 20 and 30 degrees' inclination according to Table 1. This is with the conditions stated in the table. The view of the inlet obtained with the inlet and film parallel, as described by Thoms and shown in Figure 4, has the anteroposterior diameter slightly more enlarged than the transverse diameter because the latter diameter is below the former and therefore closer to the film. It was decided for the purpose of affording easier comparison of films taken by these two methods to use the 12.5 degree tube angulation. This particular deviation from the vertical also gives a more truly proportioned image in those cases in which the pelvic inlet is inclined more than 30 degrees with respect to the film.

Table I

DISTORTION OF THE PELVIC INLET AT VARIOUS ANGLES OF ROENTGENOGRAPHY

Deviation of central ray from vertical	Inclination of pelvic inlet with reference to plane of film			
	40°	30°	20°	10°
	cm.	cm.	cm.	cm.
10°	12.05	12.9	13.2	13.4
12.5°	12.4	13.2	13.3	13.5
15°	12.95	13.6	13.6	13.65
25°	14.8	15.0	14.5	14.1

The values are the length of the projection on the film of 11 cm. of anteroposterior diameter. The projection of 13 cm. of transverse diameter at 8 cm. above the table measures 15.5 cm. at all angles. Anteroposterior film with patient supine. Target film distance, 30 inches. Promontory to table, 9 cm. Table to film, 4 cm.

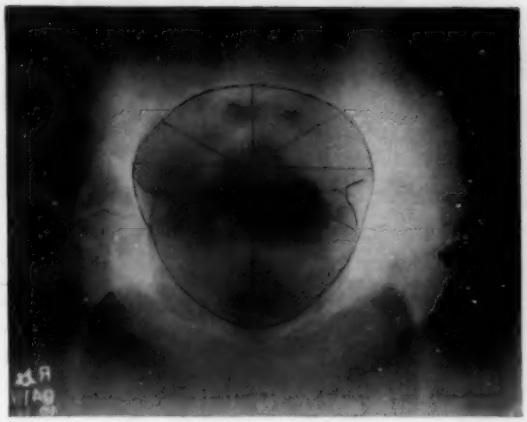

Fig. 4. View of same inlet as in Figure 3. Inlet and film parallel as in technique of Thoms.

Figure 4 shows the same pelvis as Figure 3. Comparison of the films from which these illustrations were made shows the outline of the inlet to be almost but not quite the same. The principal difference between the films is that the one made with the central ray deviated from the vertical while the patient was in the supine position shows the ischial spines to be placed more anteriorly and also shows more of the ischial tuberosities and obturator foramina. In this method, the obliteration of the obturator foramina, which is stressed in some methods as a prerequisite to establish

the amount the central ray should be deviated from the vertical in order to obtain a projection of the inlet in true proportion, is not only unnecessary but also impossible. To cause these foramina to appear obliterated as in Figure 4 the central ray would have to pass through the pelvis almost perpendicular to the plane of the superior strait. This would be at an angle of about 25 degrees' deviation from the vertical. At this angle the projection of the anteroposterior diameter would be too long in comparison with the enlargement of the transverse diameter to demonstrate the inlet in its true proportions. This can be seen by reference to Table I and the ratio which was previously solved to establish the desired length of the anteroposterior diameter. The views of the inlet obtained by using a deviation of 12.5 degrees from the vertical for the central ray are not quite in absolutely true proportion but the distortion is not significantly apparent.

To study the accuracy of this method of pelvimetry in a manner which should simulate pelvimetry in the living woman, 7 post-mortem cases were examined roentgenologically and the dimensions derived from the roentgenograms were compared with the actual diameters grossly measured at autopsy after evisceration. These latter measurements were made by Dr. L. V. Dill of the Department of Pathology of Duke University. Autopsy measurements and measurements of the roentgenograms were each made independently without knowledge of the other. Table II shows the results of this work.

It is possible that the accuracy of the roentgen measurements might have been increased if the same table had been used for the examination of the autopsy cases as that which was used when the living cases were roentgenographed. A hospital cart and portable apparatus were used in making the roentgen examination of the autopsy cases. The obstetrical conjugate which was considered the easiest of the diameters to measure accurately at the autopsies shows the closest correlation between roentgen measurements and the actual measurements on the cadaver, with an error averaging 1.7 mm.

The cephalometry for the clinical cases which follow was done from the films used for the pelvimetry. The method and chart of Walton were used for this purpose. It is to be noted that as the central ray used in the taking of the anteroposterior film was not perpendicular to the film as Walton uses, the distance from the target to the film is actually slightly longer than 30 inches. The error introduced by this is not over 2 mm. and is of such a nature as to make the roentgen measurement of the

TABLE II

COMPARISON OF ROENTGEN AND ACTUAL POST-MORTEM PELVIMETRY

Case	I	II	III	IV	V	VI	VII	Av.
Diameter								
Obstetrical conjugate								
Anteroposterior film	2	0	1	5	− 3	−1	0	1.7
Lateral film	0	−1	2	0	0	4	−5	1.7
Average	1	−0.5	1.5	3	− 2	2	−2.5	1.7
Transverse	2	10	7	−1	− 2	2	−5	4.1
Right oblique	4	−1	−1	−6	−10	−2	2	3.7
Left oblique	5	1	−3	−6	−10	−1	1	4.1
Bi-ischial	1	−2	2	2	− 5	−6	−4	3.2

Positive values indicate roentgen measurements too great by the amount shown in millimeters and negative values indicate roentgen measurements too small by the amount shown in millimeters.

fetal head slightly too large. That is, the skull is really smaller than the measurement indicates. As it is only the bony position of the head which is measured on the film and the actual measurements of the head of the living child must include 1 or 2 mm. for the soft tissues, the effect is to bring the actual measurement nearer the value of the slightly overestimated roentgen measurement and thereby compensate for the original error.

Of 60 cases studied at Duke Hospital in 1937, 3 are selected to illustrate the application of this method in each of the three non-gynecoid types of pelves. Two of these which had been put to a test of labor are presented because they are believed to give some indication of the accuracy of the method.

Case 1. A white primipara at term, aged twenty-one.

External measurements:

Interspinous	25 cm.
Intercrestal	28
Bitrochanteric	29
External conjugate	22
Bituberous	10

Roentgen measurements:

Obstetrical conjugate	12.6
Transverse of inlet	12.2
Right oblique	12.0
Left oblique	11.3
Bi-ischial	10.0

Position:

The fetal head is in the left occipito-anterior position unengaged.

Biparietal	10.2 cm.
Occipitofrontal	12.4

Roentgen report: "There is an asymmetrical anthropoid type of pelvis with oblique contraction which should make labor difficult."

The patient was admitted in labor and continued in labor for fifty-five hours with strong contractions every three minutes for much of the time. These pains lasted forty-five seconds. The cervix was dilated one and one-half fingers and there was no engagement. Cesarean section after fifty-five hours of labor resulted in the delivery of a normal living child. The actual diameters of the fetal head were biparietal 10.1 cm., and occipitofrontal 12.4 cm.

Figure 5 shows the relations as seen in the anteroposterior film pertaining to this first case. This plate was taken seven hours after the onset of labor. Study of this film and of a reconstruction in plaster of this pelvis and fetal head according to the dimensions given above and including a suboccipital-bregmatic of 10.5 cm. shows that the head is in the most favorable position for engagement to occur when it is with the long axis of the head in the right oblique diameter as it was during labor. Engagement in any other position is absolutely impossible. For the head to enter the pelvis while in the left occipito-anterior position the degree of flexion would have to be so marked that it would be impossible to expect engagement to occur. In this instance, even if the engagement were possible, one might expect difficulty when the biparietal diameter passed between the ischial spines.

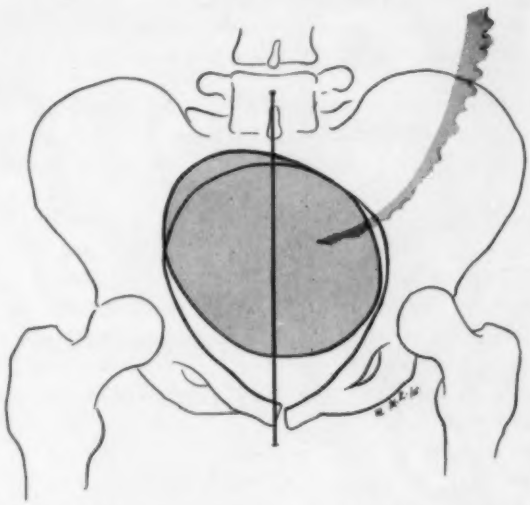

Fig. 5. Tracing from anteroposterior film, Case 1, showing asymmetrical anthropoid inlet. Shaded portion represents fetal head and spine.

Case 11. White multipara, aged thirty, at term.

History. Previous pregnancies include, in the order of occurrence, a breech extraction with neonatal death, a spontaneous abortion at three months, a spontaneous delivery at term of a living child with the head rotating from right occipito-posterior to right occipito-anterior.

External measurements:

Interspinous	24.0 cm.
Intercrestal	27.0
Bitrochanteric	31.0
External conjugate	19.0

Roentgen measurements:

Obstetrical conjugate	10.0 cm.
Transverse of inlet	14.5
Right oblique	12.0
Left oblique	11.5
Bi-ischial	12.0

Position: The fetal head is in an occipito-anterior position, unengaged.

Biparietal	10.0 cm.
Occipitofrontal	not determinable.

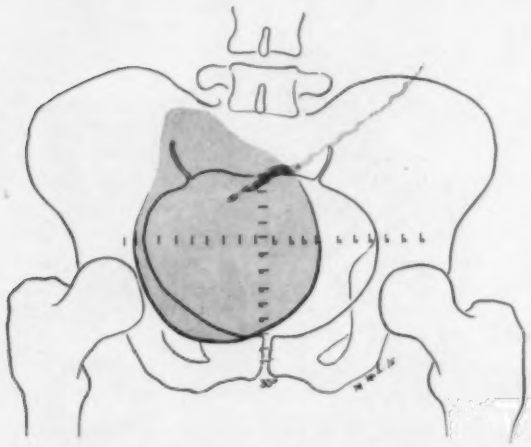

FIG. 6. Tracing from anteroposterior film, Case II, showing platypelloid inlet with scales applied. Shaded portion represents fetal head and spine.

Roentgen report: "The pelvic inlet is of the platypelloid type. It is questionable whether or not there will be a natural delivery."

The patient was admitted to the hospital three hours after the onset of labor and was in labor seven hours without engagement occurring. The contractions were regular and finally occurred every two minutes and lasted from thirty to fifty seconds. The contractions finally became very severe and cesarean section was performed in order to obviate the possibility of a ruptured uterus. A living child was obtained. The dimensions of its head were biparietal 10.2 cm., and occipitofrontal 13.0 cm. Figures 6 and 7 show the relationships as seen in the lateral and anteroposterior films. The lateral film shows over-riding of the bones of the fetal skull and impingement of the head on the promontory of the sacrum. The sacrum is seen to have an unfavorable curvature projecting into the pelvic cavity which would hinder labor if engagement should occur. The fetal head was found to be above the normal size of 9.25 cm. Biparietal both by roentgen and actual measurement, and as engagement did not occur during labor the statement that the anteroposterior diameter of the pelvis was shorter than normal or at least not adequate to permit this fetal head to pass, should be correct. The obstetrician who performed the cesarean section also conducted the previous spontaneous delivery at which a living child was obtained. He stated that the child born at the spontaneous delivery was definitely not as large as the later one requiring the section. It was possible then in this case for a normal or possibly smaller than normal fetus, as far as the head is concerned, to pass through this pelvis and be born in a natural delivery. An anteroposterior diameter of 10.0 cm. as stated in the roentgen measurements would fulfill the conditions in the presence of all other diameters being adequate, which would permit the birth of a normal-sized head and give difficulty with one which was larger than normal. The roentgen measurement in this case should therefore

FIG. 7. Lateral film, Case II.

be correct as judged from the results of previous labor with a smaller fetus and failure of engagement to result in a test of labor with a fetus having a larger head than normal.

Case III. A primipara at term, aged thirty-eight, who was admitted to the hospital with the complaints of frontal headache, vertigo, epigastric pain, and ankle edema. These complaints had their onset three weeks prior to admission to the hospital. The blood pressure was 170/110. The diagnosis was pre-eclamptic type of toxemia in a pregnancy at term, and an android pelvis.

External measurements:

Interspinous	23.0 cm.
Intercrestal	31.0
Bitrochanteric	33.0
External conjugate	21.0
Diagonal conjugate	"Not reached"
Bituberous	7.5
Post-sagittal	9.5

Roentgen measurements:

Obstetrical conjugate	12.5 cm.
Transverse of inlet	12.4
Right oblique	12.0
Left oblique	12.0
Bi-ischial	8.4

Position: The fetal head is unengaged in the right occipitotransverse position.

Biparietal	9.5–9.7 cm.
Occipitofrontal	11.8

Fig. 8. Anteroposterior film, Case III, showing android inlet and narrow bi-ischial diameter.

Fig. 9. Subpubic arch film, Case III, showing narrow bi-ischial and narrow bituberous diameters.

Roentgen report: "The pelvis is of an android type and the contraction of the outlet should make labor difficult with a fetal head of this size."

After treatment of the toxemia for two days a living child was delivered by means of cesarean section. The mother recovered well. The actual measurements of the fetal head were, biparietal 9.4 cm., and occipitofrontal 11.6 cm. This case is presented to illustrate the application of pelvimetry to the measurement of a contracted bi-ischial diameter not susceptible to direct clinical measurement, in a case of labor complicated by both toxemia and dystocia which made a trial of labor inadvisable. The films pertaining to this case are shown in Figures 8 and 9.

SUMMARY

1. Two cases without an extreme degree of dystocia have been put to a test of labor. The circumstances pertaining to these two cases are used to demonstrate the accuracy of the method.

2. A method of measuring the bi-ischial diameter and its clinical application is illustrated.

3. Experimental work was done on cadavers in order to determine the accuracy of the method.

4. A method of pelvimetry is presented which is technically simpler than methods requiring the plane of the pelvic inlet to be parallel to the film, or involving reconstruction of stereoscopic images. An advantage is that the mass of tissue pene-

trated by the roentgen rays is less when the patient is supine, as in this method, than when the patient is sitting. The anteroposterior film therefore shows better definition.

5. The scale is adaptable for use on films made with apparatus having a table to film distance other than 4 cm. by renumbering the scales.

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Vol. 42, No. 6

THE PRESENT STATUS OF ROENTGEN TREATMENT OF SINUS INFECTIONS*

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IRRADIATION of sinus infections has been much emphasized during the past few years, especially by Butler and Woolley,[1] Hodges,[9] and Rathbone.[14] Because of the publicity which this treatment is now receiving, we are prompted to review the subject and present our impression regarding this form of therapy.

Otolaryngologists and radiologists have, for a long time, been aware of the frequent relief of pain following the taking of roentgenograms in patients suffering from acute sinusitis. Only small doses are necessary to effect these changes, assuming them to be due to the roentgen ray.

Osmond[13] was probably the first to report on the actual treatment of sinusitis with roentgen rays, and in 1923 gave his results in 12 cases, the first being treated in 1916. In 1930, Butler and Woolley,[1] at the University of Oregon Medical School, reported the results in the treatment of 100 cases of chronic nasal accessory sinusitis and were able to conclude that 31 per cent of the patients became symptom free, 50 per cent definitely improved and 19 per cent were unchanged. Their cases had failed to respond to all other forms of therapy.

In 1934 these same authors reported further observations in the roentgen treatment of chronic sinusitis and included experimental work consisting of producing changes in the mucous membrane of the frontal sinuses of cats similar to those caused by infection in man. This work was done in conjunction with Dr. Ralph Fenton of the Department of Otolaryngology and Dr. Olof Larsell of the Department of Anatomy of the University of Oregon Medical School. In their earliest work they employed 12 cats, and the right frontal sinuses were punctured and infected with a virulent hemolytic streptococcic culture taken from a mastoid. All the cats showed definite evidence of infection within a few days and two died as the result of it. They determined upon three weeks as the duration under which infection should be kept alive and at the end of this time the remaining 10 cats were sacrificed and divided into three groups. Group 1 consisted of three cats which were irradiated over both frontal sinuses and given 800 r in air. Group 2 consisted of three cats which received 1,600 r over both frontals, the increased dose being given in order to determine if and what harmful results might occur from excessive irradiation. Group 3 consisted of the four remaining cats which had been infected but were not irradiated, and these were used as controls.

"One cat from each group was killed at the end of one week, a second at the end of three weeks, and a third at the end of three months, following irradiation. The sinuses were exposed for gross inspection and the anterior portions of the skulls were then placed in Zenker-formal solution. After the membranes had hardened, they were rolled . . ., blocked, sectioned and stained. It then appeared advisable to determine the earlier changes that might take place in the first few days following irradiation. Accordingly another series of cats was prepared as before and killed 24, 48, and 72 hours following irradiation. The membranes were processed as above mentioned."

Larsell summarized the effect of irradiation on infected mucous membranes of the sinuses as follows:

> The effect of the x-ray treatment appears to be due primarily to an early destruction of the lymphocytes in the infected membranes. About 48 to 72 hours after treatment of membranes which had been infected for several weeks, there appears to be an increase in the number of macrophages. These are believed to come in response to substances released by the breaking down of the lymphocytes. These macrophages are seen to be laden with cellular débris

* Read at the Thirty-ninth Annual Meeting, American Roentgen Ray Society, Atlantic City, N. J., Sept. 20–23, 1938.

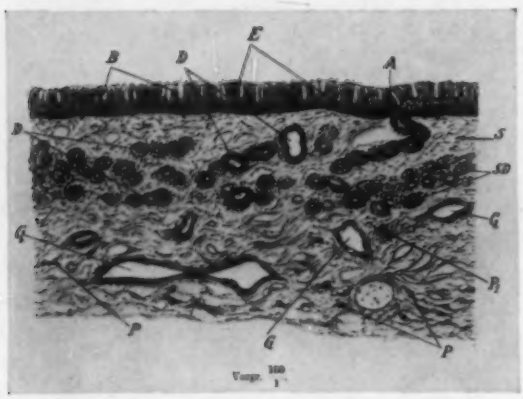

FIG. 1. Normal sinus membrane. *A*, orifice of mucous glands; *B*, goblet cells; *D*, collections of glands; *SD*, mucus in glands; *G*, vessels; *P*, pigment in spindle cells; P_1, scattered pigment; *E*, ciliated epithelium; *S*, connective tissue. Note the absence of leukocytic infiltration of the submucosa. (From "Atlas der Histopathologie der Nase und ihrer Nebenhöhlen," Bauer-Beck.)

and dead pigments. It is possible that they also engulf bacteria.

The membrane becomes gradually reduced in thickness but retains numerous plasma cells, polymorphs, and some histocytes. After a week or more some fibrosis appears.

There is no evidence of injury to the cilia, epithelium, or cellular elements other than the lymphocytes as the result of x-ray dosage. The fibrosis is considered a result of the inflammatory process, and the increased number of histocytes immediately following the infection."

Butler and Woolley[1] reported their clinical experiences based on a series of 700 cases treated by irradiation and were able to draw the following conclusions, namely, that roentgen therapy has a definite place in the treatment of chronic paranasal sinus disease, that when properly applied there is no danger, and that failure of roentgen therapy in no way interferes with subsequent surgery, should the latter become necessary.

Therefore, it is quite obvious from this excellent though small series of experiments that there is a sound basis for the radiation treatment of sinusitis. The problem which now arises relates to determining which type of sinus infection falls in the domain of the radiotherapist. We have adopted a classification which has as its basis the various types of histological change noted in different stages of infection.

The normal sinus membrane (Fig. 1) is lined with columnar ciliated epithelium. This rests on a very thin basement membrane which is apparently derived from the connective tissue of the submucosa. Between the epithelial cells one sees many goblet cells and the openings of glandular structures which extend far down into the submucosa. The submucosa is made up of connective tissue which may be slightly infiltrated by leukocytes. When one considers the great frequency of inflammations of the nose and its accessory sinuses the presence of such leukocytes to more than a very slight degree naturally suggests that the

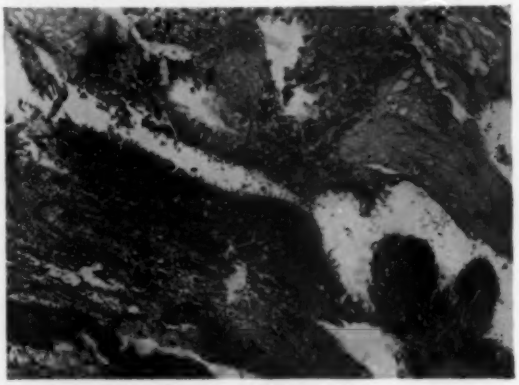

FIG. 2. Subacutely inflamed sinus membrane. The tissue immediately beneath the epithelium is edematous and heavily infiltrated with large numbers of lymphocytes and polymorphonuclear cells.

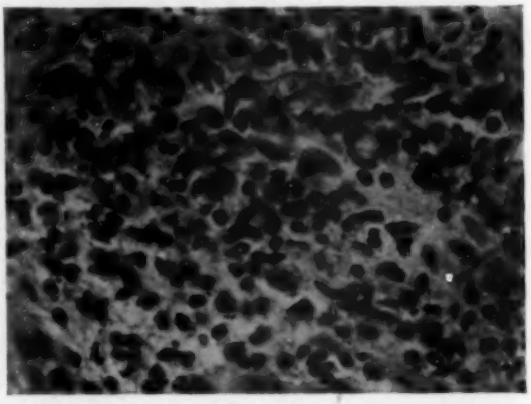

FIG. 3. Higher magnification of Figure 2 showing cellular infiltration more clearly.

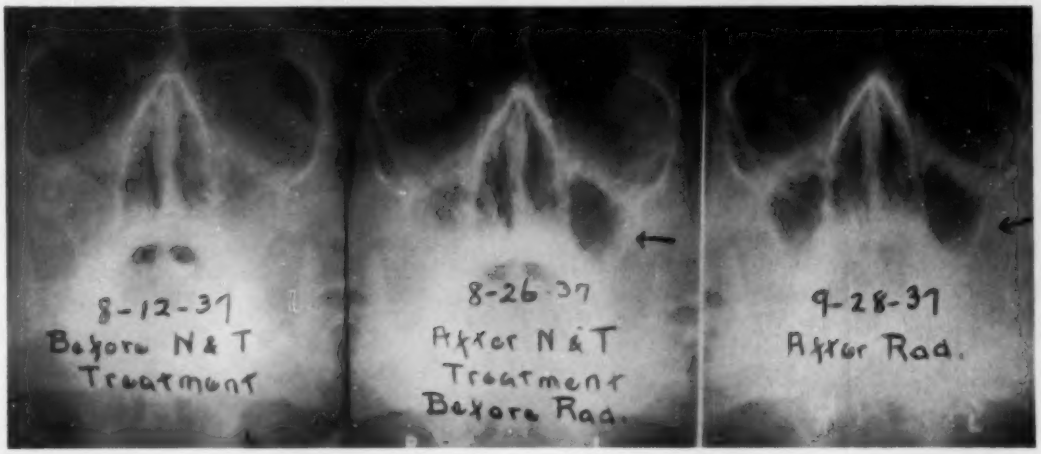

Fig. 4. Roentgenograms of a patient with subacute sinusitis who received radiation therapy.

membrane is not normal, even though the patient may be entirely free of symptoms.

1. Acute sinusitis. Most of these cases clear up under the usual treatment of inhalations, packing, suction, and washings. Because of this, as well as the tension in the affected sinus, roentgen treatment is not indicated. After good drainage has been established, one or two small doses may hasten convalescence. In our opinion, it is wise to withhold irradiation for other types, even though the underlying pathology is like that of any other acute infection. The membrane becomes edematous, heavily infiltrated with leukocytes, and pours forth a dense inflammatory exudate. We were unable to obtain a membrane in this stage of infection because radical operations are never performed until the process has subsided to some degree.

2. Subacute sinusitis. These cases constitute a group not treated nor cured by the usual methods. When examined roentgenographically after washing, the antra are observed to have very thick membranes enclosing a small air space. Unless treated by radical operation or irradiation, they often become chronically infected. The membrane, being filled with lymphocytes and a smaller number of polymorphonuclears, is very radiosensitive. Figures 2 and 3 are photomicrographs of a section of sinus membrane during subacute inflammation. It shows intact ciliated epithelium. The tissue immediately beneath the epithelium is edematous, but it is heavily infiltrated with large numbers of lymphocytes and polymorphonuclear cells. A dense inflammatory exudate is noted on the surface of the epithelium. Such pronounced leukocytic infiltration renders this type of membrane radiosensitive.

Figure 4 illustrates the roentgen findings in such a case. The patient was hospitalized for ten days following the film taken on August 12, 1937. During this acute stage she received inhalations, nasal irrigations and local applications. She improved considerably, but still had a moderately productive cough with nasal obstruction. At the time of discharge by the otolaryngologist a film disclosed marked shrinkage of the mucous membrane, but it was still definitely thickened. It is probable that convalescence would have occurred had no irradiation been given at this time, but there is little doubt that irradiation which was begun on August 26, 1937, hastened convalescence very considerably and may have prevented a chronically recurring infection. The patient commented spontaneously on the striking improvement which she noted within the first hour following her first exposure. She was able to breath more easily and the mucus in her throat decreased very markedly. She received 600 roentgens in

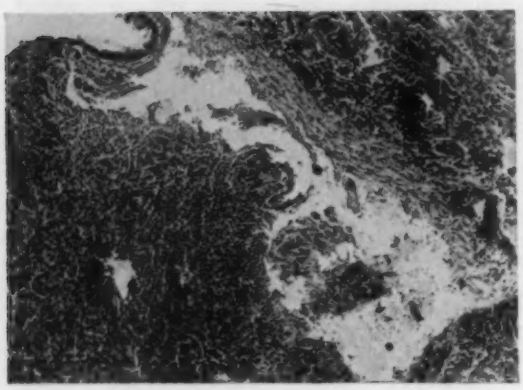

Fig. 5. Chronically infected sinus membrane showing dense cellular infiltration of submucosa.

six treatments during the following month. Her sinuses appeared clear on September 28. Since that time she has been in excellent health. One of the noteworthy aspects of this type of case relates to the fact that many patients may show thickened membrane when discharged by the rhinologist and that such membrane is likely to be radiosensitive. During the past year we have seen a number of such patients who have been discharged as clinically well, some of whom we have treated with great success. This, in our opinion, should be stressed.

3. Chronic sinusitis with thickened membrane, but without polyp formation. This group is made up largely of patients who did not consult a rhinologist sufficiently early. Others have not been adequately treated or have resisted the usual forms of treatment.

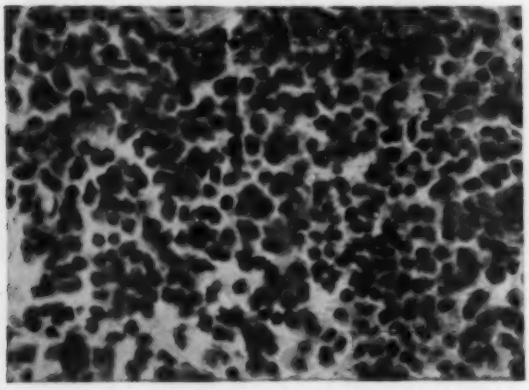

Fig. 6. Higher magnification of submucosa shown in Figure 5.

This group is also very radiosensitive, being only slightly less so than the subacute group. Microscopic section (Fig. 5) shows dense infiltration of the submucous area by large numbers of lymphocytes and a moderate number of polymorphonuclear and plasma cells. This is more plainly seen in the higher magnification (Fig. 6). The mucous glands appear normal. One can expect a favorable reaction to irradiation here also because of the cellular infiltration of the submucosa.

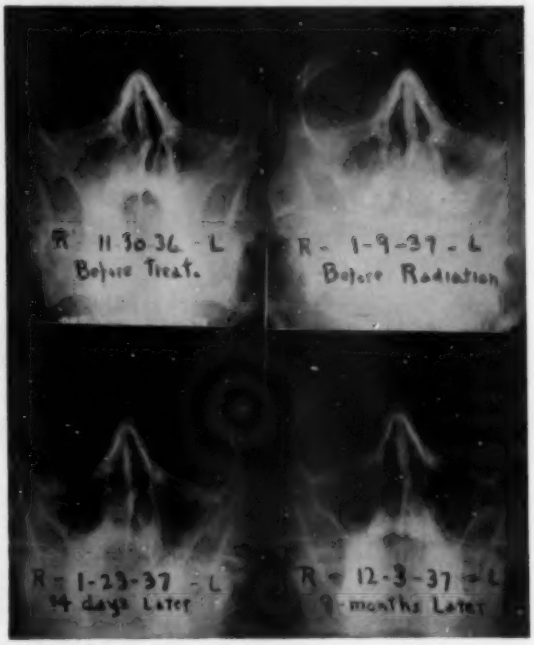

Fig. 7. Roentgenograms of an adult with chronic sinusitis relieved by irradiation.

The following case reports are illustrative:

Case 1. W. P. M., male, aged thirty-five, had infected tonsils until he was twenty years of age. He had about eight or ten colds per year as a child and as an adolescent. His tonsils were removed at the age of twenty. For about ten years he was practically free of colds, but then began to have a series of colds, except during his residence in Florida. Upon coming to Baltimore in 1935 he developed about eight colds yearly, especially during the winter months. During these infections he had to remain in bed for three or four days. In November, 1936, he be-

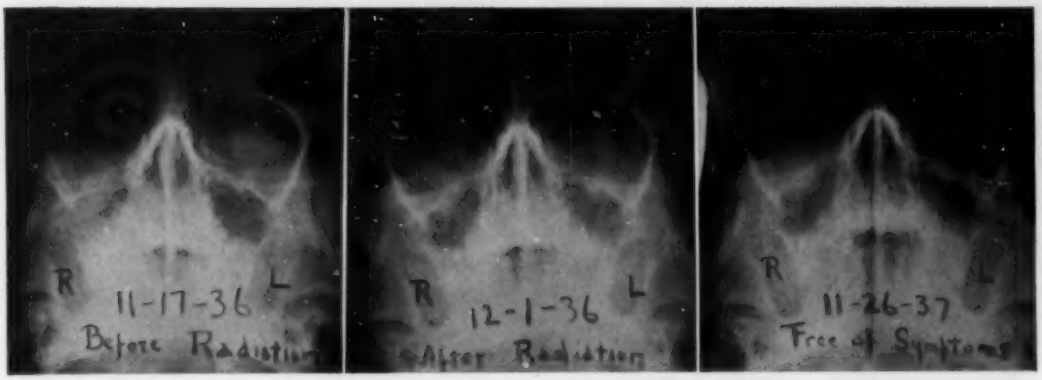

Fig. 8. Roentgenograms of a child with chronic sinusitis relieved by roentgen therapy.

gan what appeared to be a similar series. Roentgenography of the sinuses at that time (Fig. 7) disclosed marked thickening of the mucous membrane in both antra. Until January 9, 1937 there was no improvement and the patient was seriously considering resignation from his local position and returning to Florida. Roentgenographic examination on January 9, 1937, disclosed less thickening of the antral membrane, but it was still very pronounced. The patient was given a total of 525 r in five treatments between that date and January 23, 1937. Definite improvement was noted on January 18. Roentgen examination on January 23, 1937, disclosed definite decrease in size of the membranes. The sinuses were clear on December 13, 1937. When last seen on August 7, 1938, the patient's sinuses appeared clear and he reported that he had been entirely free of colds since roentgen treatment.

Case 11. J. C. F., male, aged nine, first seen on November 17, 1936. For four years he had been subject to a cough of a mildly productive nature, especially during the winter months. His tonsils had been removed. Films of the chest, taken elsewhere, had been variously interpreted as showing tuberculous and nontuberculous infiltration. For several months prior to his visit he had so many repeated attacks of head colds and bronchitis as to prevent his attending school. Examination of the chest on November 17, 1936, showed increased root shadows suggestive of bronchitis. There was opacity of the right antrum (Fig. 8) suggesting a chronic infection. Treatment was begun November 20, 1936, a total dose of 420 r being given between that date and December 1. His cough lessened within four days after the first treatment and he was able to return to school. On December 1 the cough had disappeared completely and his sinuses appeared clear on roentgen examination. He had a slight head cold early in January which cleared in a few days. His sinuses appeared clear on November 29, 1937. There had been no essential change in the appearance of his chest although all respiratory symptoms had disappeared. He has been in excellent health since the early part of 1937.

4. Chronic sinusitis with much scar tissue or polyp formation. This group constitutes a later developmental type in the course of sinus disease. Because of the presence of scar tissue and relatively little cellular infiltration this group is less sensitive than the preceding, although early scar tissue and polyp formation may be affected moderately by fractional highly filtered

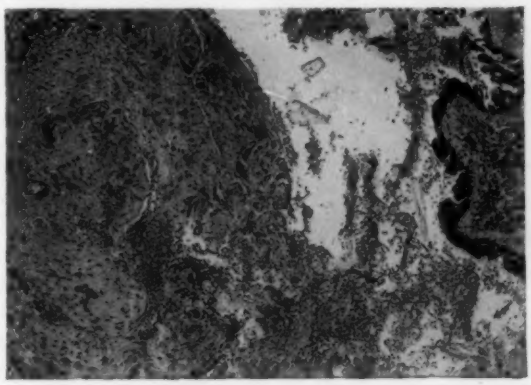

Fig. 9. Chronically inflamed sinus membrane showing much fibrosis and relatively little cellular infiltration.

radiation, whereas later fibrosis and polyposis is affected only slightly, if at all. Microscopic section (Fig. 9) shows fibrosis with relatively little leukocytic infiltration. Figure 10 is illustrative of such a patient who had a long history of infection, but in whom relief of symptoms was obtained

FIG. 10. Chronic sinusitis, probably with much scarred membrane. No roentgenographic change noted, although patient experienced some relief of symptoms.

without roentgenographic change. Figure 11 is a photomicrograph of a section which shows a polyp made up of loose areolar and edematous tissue with only slight cellular infiltration. There is evidence of beginning retention cysts. Figure 12 is a roentgenogram of this type of lesion.

5. Atrophic sinusitis. This group is radioresistant.

It is our earnest desire to cooperate with the internist and rhinologist in every way in order that allergic sinus disease and other types be properly determined prior to the institution of roentgen therapy. It is obvious that only certain types of sinus disease are amenable to irradiation. Allergic cases are unlikely to respond to the irradiation unless there is associated infection. Lymphoid hyperplasia in the nasopharynx in children in association with thickened sinus membranes is of great significance to the radiologist, as these cases do exceedingly well under irradiation. This has been indicated by Rathbone in a recent article. Good drainage in subacute infections and

FIG. 11. Polyp, showing edematous areolar tissue, slight cellular infiltration, and beginning formation of retention cysts.

FIG. 12. Roentgenogram of patient with polyp in left antrum.

open ostia in the chronic group are most desirable. The removal of infected tonsils and adenoids, submucous resections and nasal polypectomies have been found to be of primary importance for permanent relief of this distressing condition. In consideration of the fact that the vast majority of our patients had received nose and throat care, including the ordinary operations, we feel that irradiation is worthy of trial in these difficult cases because many of the sinus membranes contain lymphocytes as shown on histological examination.

In classifying our results we have defined cures as those cases in which symptoms disappeared completely and the sinuses became clear. This is true in 34 per cent of our series. Cases reported as markedly improved are those in which symptoms disappeared completely or almost completely, but the sinuses remained slightly opaque as determined on subsequent roentgen examinations. This group constitutes 38 per cent of our cases. Those reported as moderately improved were relieved only for a few weeks or months. These make up 13 per cent of our group. Some patients have had radical operations or sinus disease of long standing and have been included in this and the preceding group because these will never become clear. Others have been included with those in whom no results have been obtained, which is true of 15 per cent of our cases. Therefore, we are able to conclude that approximately 70 per cent of properly selected cases of sinusitis can be cured or markedly improved by irradiation.

Rathbone,[14] in a series of 124 cases of chronic sinusitis in children treated by irradiation, observed that 57 per cent were cured, 28 per cent improved, and 15 per cent were not affected.

Hodges[9a] obtained cures or marked improvement in approximately 80 per cent of his cases.

Butler and Woolley[1] report 36 per cent cured, 55 per cent definitely improved and 9 per cent either influenced slightly or not at all.

Technique. The use of prolonged and intensive therapy is not necessary. We have had excellent results after four biweekly doses of 100 r each, measured in air. At times it has been necessary to use 600 r over a three-week period to obtain the maximum desirable result. This dose, delivered at 125 kv., 5 ma., 35 cm. focal skin distance and with filtration of 4 mm. aluminum, is about 45 per cent of the amount which would produce the slightest erythema under the same circumstances. The prevention of any epilation is provided by routinely covering the hair, eyebrows and eyelashes with strips of lead. In children the dental buds in the maxilla are similarly protected. Most radiation therapists prefer the use of fractional doses, although Butler and Woolley used our approximtae dose as measured in air at one sitting. Fractional doses give the operator better control, tend to avoid possible unpleasant sequelae, such as headache, and will permit the administration of a larger dose should this be necessary.

SUMMARY

Irradiation is finding a progressively wider range of usefulness in paranasal sinus infections by virtue of the fact that many subacute and chronically infected sinus membranes are infiltrated with lymphocytes. This is frequently true of patients who have not responded to other types of therapy. The dosage required is well within the limits of safety. We hope that radiologists will not accept patients indiscriminately as such action may be detrimental to the method. This can be avoided largely by proper cooperation with the rhinologist.

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DISCUSSION

DR. FRED M. HODGES, Richmond, Va. The study that Drs. Waters and Firor have made of the pathology of sinus infection certainly should help to clarify the indications for roentgen therapy in this very controversial field. We as radiologists are going to get better results in this condition if we pay particular attention to sinus disease and learn all that we can about the anatomy, histology and physiology of the sinuses and understand the pathology of the various types of disease. Sinus disease is not just a simple infection to be treated as the usual local infection would be. There are so many different things that play a part in these infections; for instance, allergy, poor drainage from anatomical abnormalities, formation of polyps, etc.

We are using about the same classification as given in this paper and have obtained approximately the same results. An accurate history is always essential. Many of the subacute cases are seen after a more or less acute exacerbation and from the films alone we are many times unable to determine whether or not the pathology present is radiosensitive. By going thoroughly into the history this point can frequently be determined. Also the necessity for allergic or other studies will be brought out. In all of these cases that have not been seen by the rhinologist, we have insisted that this examination be made before beginning roentgen therapy, otherwise a closed antral ostium or polyp formation in the nose may prevent a good result being obtained. In early polyp formation a fair percentage are radiosensitive and good results can be obtained. A good many patients who have been unable to breathe through the nose and have lost the sense of smell may get drainage and have a return of the sense of smell. Large polyps in the antrum practically never respond to this therapy. In a good percentage of cases where there was sinus infection and where the patients were definitely allergic, roentgen irradiation has helped to clear up the infection. We do not believe that all cases of sinus disease in allergic individuals should be declined roentgen therapy. This therapy in addition to treatment by the allergist has here been of definite value just as it is in eczema. The allergist can in time clear up eczema but when roentgen therapy is added a much quicker result is obtained. In our experience many allergic individuals show no roentgen evidence of sinus disease. Most of the allergic individuals that we have treated have been referred to us by an allergist and by combining the two methods of treatment, many times a quicker result can be obtained.

Many rhinologists are not as opposed to this form of treatment as they were two or three years ago, and some of them are working with us in a conscientious effort to get the patient the best result. We believe that in acute and subacute cases with an antrum full of pus the antra should be washed. If the ostia are closed, there is apt to be a rather severe reaction following roentgen therapy.

DR. GEORGE W. GRIER, Pittsburgh, Pa. I would like to say a word about the necessity for selecting the proper type of case for treatment, and that brings up, of course, the classification of sinusitis. It might be well to call to our minds just how a patient gets infection of the sinuses.

Most of these cases, of course, result from an acute infection. The patient has influenza, for instance, and he develops an acute sinusitis. The greater percentage of those cases recover spontaneously. You will see them all the time.

Two nurses in my office during the time they worked for me had grippe or "flu" and developed an acute infection in the antrum. The antrum was full of pus. Eventually, it discharged and they have been perfectly well for years since. That is the common thing.

But in other cases in which drainage is bad, this acute infection goes on until it becomes chronic infection. They get drainage from time to time and they get over the acute attack. After a while they get another attack with an acute flare-up and the sinuses fill up again, and that goes on for years. That type of case is a chronic, suppurative sinusitis and, in my experience, that type of case does not respond to roentgen treatment.

In the other type of sinusitis, the hyperplastic sinusitis, there is the thickened membrane with occlusion of the ducts and the development of small cysts and polyps. Sometimes these membranes will become a quarter of an inch thick or even more. That type of sinusitis is not supposed to be due to infection, so it is really not correct to speak of this kind of case as an infection. That is the type of case in which there is extensive lymphoid infiltration and in which it is proper to use roentgen therapy and in which you will get good results. That kind of case may get an acute infection and the antrum may fill up with pus. It is hardly correct to call that a subacute case. That is a chronic hyperplastic sinusitis with acute suppuration grafted on.

I believe that the only type of sinusitis in which you can hope to get good results is the hyperplastic type. You may not influence the polyps, but where there are polyps there is this hyperplasia of the mucus membrane and that is the proper kind of case to treat. Personally, I have not had any good results in the treatment of chronic suppurative sinusitis, but in the hyperplastic type there is a good chance for improvement.

Dr. Firor (closing). Dr. Hodges came to Baltimore a few years ago, filled with enthusiasm regarding this method, and it is through him that we began treating these cases of sinusitis. I appreciate his discussion very much.

We cover the eyebrows and eyelashes with small strips of lead, simply because of the fact that at times the operator of the machine may have a mental lapse and give an overdose of roentgen radiation. When the patient loses an eyebrow, he is very much concerned about it, even though it returns six or seven weeks later. In some of our first cases, at times we treated the patient without taking this precaution because we realized that the dose was not in itself an epilating dose. In these cases we had no untoward results or untoward reactions.

Our cases of chronic sinusitis have not been suppurating, but they certainly have had a definite history of recurring acute attacks. I feel that those patients must have had in the beginning an acute infection which has never cleared up. I would like to have Dr. Grier elucidate a little more, if possible, as to what produces this so-called chronic hyperplastic sinusitis, if it is not due to infection.

Dr. Grier: I could answer it very quickly by saying that I don't know, and I am not certain that the rhinologist does. Hyperplastic sinusitis is very common in children and I think most cases of sinusitis start in childhood but they insist that it is not an infection; it is an inflammation. That may be; allergy may be at the base of it. I am not certain. But certainly it is a different entity entirely from the chronic suppurative type. It is not at all uncommon for hyperplastic cases to get infection superimposed, but the true chronic suppurative sinusitis without hyperplasia does not have thickened membrane, and if the patient has this real thick membrane you know that he has a hyperplastic sinusitis, whether or not he has pus in addition.

DEEP ROENTGEN-RAY THERAPY OF MAMMARY CARCINOMA*

III. FIFTEEN YEAR RESULTS IN A FORMERLY PUBLISHED GROUP AND A STATISTICAL ANALYSIS OF 1,200 CASES TREATED BETWEEN 1922 AND 1937

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THE value of deep roentgen therapy in mammary carcinoma, both as an adjunct to surgery in the operable and as a primary method in the inoperable cases, is now almost universally recognized. A voluminous literature, comprehending illustrious publications from nearly every corner of the globe, would tend to support the presumption that nothing new could be added to the subject. It appeared to the authors, however, that an analysis of a large group of cases over a long period of time might serve to bring out to greater advantage certain points which are not altogether beyond the reach of criticism and especially to offer further documentary proof for the re-affirmation of principles which must remain the basis of future therapeutic procedures in mammary carcinoma. This article, presented with this view in mind, is divided into two parts: (a) the first is a continuation of two former publications[1,2] in 1925 and 1930, on a carefully selected series of 172 cases of mammary carcinoma treated between 1922 and 1924, which were studied systematically year by year; (b) the second contains an analysis of all routine cases of carcinoma of the breast treated at Harper Hospital since that time. To facilitate a better comparison, the original series is included so that the material represents a total of 1,200 cases treated between 1922 and 1937. The article published in 1925 gave the clinical classification of mammary carcinoma, together with a detailed technique of the irradiation procedure, while the article of 1930 discussed the five year results and, in those cases which died sooner, the average life duration. As a whole, the conclusions were reached that radiation therapy occupies a very important part in the treatment of mammary carcinoma. In the cases with regional lymph node metastases, the five year results were more than doubled as compared with purely surgical statistics, and in the cases with still wider clinical extension a notable prolongation of life with great symptomatic relief was obtained.

CLINICAL CLASSIFICATION OF MAMMARY CARCINOMA

Throughout the entire period, the following classification of the mammary carcinoma was used, depending on the stage of clinical extension:

I. Carcinoma localized to the breast proper.
II. Extension to the axillary lymph nodes.
III. Extension to the supra-, infraclavicular and cervical lymph nodes.
IV. Extension by lymphatic permeation of the chest wall, leading to nodular skin metastases, pleural metastases, pleural effusion, etc.
V. Distant metastases.

From the point of view of therapeutic procedure, the cases were divided into three groups:

a. Combination of surgery and radiation therapy.
b. Radiation therapy alone.
c. Radiation therapy in recurrent or metastatic cases formerly treated by surgery.

* Read at the Thirty-Ninth Annual Meeting, American Roentgen Ray Society, Atlantic City, N.J., Sept. 20–23, 1938.

(a) FIFTEEN YEAR OBSERVATION OF MAMMARY CARCINOMA

In the first part of the present article a further analysis of the original series is given. The cases which were apparently well at the end of five years were studied to the fifteen year period and an attempt is now being made to draw some new conclusions from such prolonged observation.

The table (Table I) showing the distribution of the series is reproduced from the former article[1] and to this is added Table II which gives a comparative arrangement of the five and fifteen year results.

TABLE I

Group	A					B					C					
Stage	I	II	III	IV	V	I	II	III	IV	V	I	II	III	IV	V	Yearly Total
1922	4	18	2	2	0	1	1	2	0	0	0	0	10	11	9	60
1923	4	11	1	3	0	0	1	3	1	2	0	2	7	8	7	50
1924	9	16	3	5	0	0	0	0	1	6	0	2	7	6	7	62
Total	62		16			3		15			4		72			
	Total cases treated					172										

It may be noted that of 172 cases of mammary carcinoma of all groups treated by various methods between 1922 and 1924, a total of 51 cases (30 per cent) survived the five year period. In the most important group of operable cases, in which a combination of radical (or semiradical) surgery and extensive postoperative radiation therapy was used, the five year survival rate amounted to 71 per cent if the carcinoma was localized to the breast proper, and 47 per cent if there was extension to the axillary lymph nodes. By placing the two groups together, the five year results were 53 per cent.

In following up the cases which survived the five year time limit, generally regarded as indicating a cure of the carcinoma, we find that many continued to die of the carcinoma beyond that time limit. Thus a re-analysis at the fifteen year period shows that of the 51 cases which survived the five year period, only 24 cases (14 per cent) were alive at the fifteen year period. Of the 27 cases who died, 16 cases died of carcinoma recurrence or metastases (10 between the five and ten year period, 4 between the ten and fifteen year period and 2 from new primary carcinoma), and 11 of other causes, mostly of old age or cardiovascular disease. It is of interest in this respect that in the operable group, 47 per cent survived the fifteen year period when the lesion was localized to the breast proper and 20 per cent when there was axillary involvement, and that 2 out of 4 in the former and 6 out of 12 in the latter, that is, half of the apparently cured cases died from carcinoma in the interim. Moreover, in 2 of the 8 cases without axillary involvement who are alive, there is now, fifteen years later, evidence of local recurrence in the scar of the breast and in another case there is a new primary carcinoma in the opposite breast. Likewise among the 9 living cases with axillary involvement, there is evidence of local recurrence in the scar at the present time in 2 cases. Thanks to the systematic follow-up, the recurrent lesions were discovered early so that there is a good probability that further arrest of the carcinoma will be brought about for a longer time or even permanently.

It results, nevertheless, from the above figures and especially from the periodical clinical examinations over a long time, that even the earliest stage of mammary carcinoma does not preclude the possibility of a

TABLE II

FIVE AND FIFTEEN YEAR RESULTS IN CASES OF TABLE I

Group	Stage		1922			1923			1924			Total			Per Cent
A	I	Cases	4			4			9			17			
		5 yr.		4			2			6			12		70.6
		15 yr.			3			1			4			8	40.6
	II	Cases	18			11			16			45			
		5 yr.		11			4			6			21		46.7
		15 yr.			6			1			2			9	20.0
	III	Cases	2			1			3			6			
		5 yr.		1			—			1			2		
		15 yr.			1			—			1			2	
	IV	Cases	2			3			5			10			
		5 yr.		—			—			1			1		
		15 yr.			—			—			—			—	
	V	Cases	—			—			—			—			
		5 yr.		—			—			—			—		
		15 yr.			—			—			—			—	
B	I	Cases	1			—			—			1			
		5 yr.		1			—			—			1		
		15 yr.			1			—			—			1	
	II	Cases	1			1			—			2			
		5 yr.		1			1			—			2		
		15 yr.			1			1			—			2	
	III	Cases	2			3			—			5			
		5 yr.		—			1			—			1		
		15 yr.			—			—			—			—	
	IV	Cases	—			1			1			2			
		5 yr.		—			—			—			—		
		15 yr.			—			—			—			—	
	V	Cases	—			2			6			8			
		5 yr.		—			—			—			—		
		15 yr.			—			—			—			—	
C	I	Cases	—			—			—			—			
		5 yr.		—			—			—			—		
		15 yr.			—			—			—			—	
	II	Cases	—			2			2			4			
		5 yr.		—			1			—			1		
		15 yr.			—			—			—			—	
	III	Cases	10			7			7			24			
		5 yr.		3			1			4			8		
		15 yr.			—			—			1			1	
	IV	Cases	11			8			6			25			
		5 yr.		1			1			—			2		
		15 yr.			—			1			—			1	
	V	Cases	9			7			7			23			
		5 yr.		—			—			—			—		
		15 yr.			—			—			—			—	
		Cases										172			
		5 yr.											51		30.0
		15 yr.												24	14.0

local recurrence or metastasis. The often heard assertion that a carcinoma localized to the breast proper (Stage I), once thoroughly removed by surgery, leads to a complete cure and that the addition of radiation therapy can produce no further improvement in the final results, needs revision. In not a few of our cases, local recurrence occurred at a later date despite the most radical surgery and very extensive postoperative irradiation, and the recurrences were or are being treated more or less successfully by irradiation. But this observation also indicates that it is unwise to speak of a "cure" of mammary carcinoma, even after the lapse of the five year period, and that the term "survival" is more appropriate for the designation of the late results.

(b) Statistical Analysis of 1,200 Cases of Mammary Carcinoma Treated Between 1922 and 1937

The second part of the article deals with a statistical analysis of all cases of mammary carcinoma treated between 1922 and 1937. In tabulating these cases, no particular attention was paid to the completeness of the treatment or to the cause of death. Whether or not the patient had a radical, semiradical or local mastectomy and whether or not the series of radiation therapy was carried out according to the original plan, the case was included in the statistics. Since the results represent "survival" figures, all patients who died were assumed to have died from carcinoma, and the 2 per cent of the cases which we were unable to trace were also included as being dead from carcinoma. In this manner, the figures represent the lowest possible values and their slight improvement may be expected from time to time, especially since experience shows that most of the untraced cases are as a rule alive.

Procedure of Irradiation. This has remained practically unchanged during the entire period of 1922 to 1937, except for some minor details inherent in the technical improvement of roentgen apparatus. Thus, as already described in the first article,[1] all cases were treated with rays obtained with 200 kv. (1 mm. Cu forefilter). In the operable group, irradiation was carried out nearly always postoperatively, by administering three series at intervals of six to eight weeks. Attention was directed chiefly to the lymph node areas of the axilla, as well as to the infraclavicular, supraclavicular and cervical regions on the affected side, but during the first series, the entire anterior and lateral thorax was also included in the field of irradiation. As a rule, four portals of entry were used on four successive days for the purpose of crossfiring and the dose on each portal amounted to 110 per cent skin unit dose given in one seance for the first, 100 per cent S.U.D. for the second and 90 per cent S.U.D. for the third series. In the inoperable, or recurrent group, the dosage, technique of procedure and number of series were adjusted to the individual requirements, and in many instances the irradiation extended over a period of many years. Especially was this true of the persistent local skin recurrences, where hypermassive doses (4–5 S.U.D.) with less penetrating roentgen rays (85 to 120 kv., unfiltered), with a technique used in skin cancers, were applied for long periods with very remarkable results. Since 1932 the primary inoperable tumors as well as the larger metastatic lymph nodes were subjected with predilection to supervoltage roentgen therapy, mostly with 500 kv. (7 mm. Cu forefilter).

In the late group, when the metastatic process occurred, as is characteristic of most cases of mammary carcinoma, in the osseous skeleton, lead therapy was associated with the roentgen therapy. As a rule 100 to 150 mg. of colloidal lead phosphate was injected intravenously a few days before each series of irradiation, the series being repeated not sooner than every eight weeks and their total number depending on the palliative clinical improvement.

TABLE III

SUMMARY OF FIVE AND TEN YEAR SURVIVALS (1922–1933)

	Group	Stage	Five Year Survivals			Ten Year Survivals		
			Total Cases	Cases Alive	Per Cent	Total Cases	Cases Alive	Per Cent
1	A	I–II	305	105	50	170	71	42
	B	I–II	15	9	60	6	3	50 (30)
	C	I–II	34	13	38	21	7	33
2	A	III	113	34	30	50	7	14
	B	III	12	3	25	7	1	14
	C	III	58	17	29	40	4	10
3	A	IV–V	66	6	9	34	—	—
	B	IV–V	63	—	—	20	—	—
	C	IV–V	164	11	7	86	2	2
Total cases of all groups and stages			830	243	30	434	95	22

Statistical Compilation and Discussion of Results. In studying the late results, it was found that of the entire group of 1,200 cases, 830 were treated more than five years ago and 434 more than ten years ago (Table III). The ratio of the early cases (I and II) to the cases which spread beyond the axilla (III, IV and V) was 42 to 58 in the

TABLE IV

A I–II. OPERABLE CASES IN WHICH A COMBINATION OF SURGERY AND ROENTGEN THERAPY WAS USED

Year	Total Cases	Yearly Cases	1	2	3	4	5	Per Cent	6	7	8	9	10	Per Cent	11	12	13	14	15	Per Cent
1922		22	22	18	17	16	15	68	15	15	13	13	13	59	13	12	12	11	9	41
1923	37	15	14	12	10	8	6	40	6	6	6	4	3	20	2	2	2	2	2	13
1924	62	25	24	17	14	13	12	48	12	11	11	11	11	44	11	11	10	6	11	
1925	90	28	27	23	19	15	14	50	13	11	10	8	6	21	6	6	5	19		
1926	121	31	29	26	23	20	17	55	16	16	15	15	15	48	15	15	29			
1927	157	36	33	24	24	19	19	53	18	16	16	15	15	42	15	46				
1928	170	13	12	10	9	9	9	69	9	8	8	8	8	62	62					
1929	190	20	17	12	10	7	7	35	5	4	4	4	71							
1930	213	23	22	17	13	10	9	39	7	7	7	78								
1931	237	24	21	20	17	12	11	46	9	8	90									
1932	264	27	24	18	14	11	10	37	10	102										
1933	305	41	40	31	27	24	21	51	120											
1934	344	39	34	32	30	28	150													
1935	378	34	32	30	22	192														
1936	425	47	39	34	247															
1937	476	51	44	320																

Average 50%

Average 42%

Average 30%

five year group and 45 to 55 in the ten year group so that we can say that in both instances more than half of the cases were too advanced to be considered strictly operable. For the whole series, the five year survival rate amounted to 30 per cent and the ten year survival rate to 22 per cent.

The detailed results for the different groups according to stage and method of treatment are presented in Tables IV to XII. To simplify the discussion, however, it appears advisable to condense the statistical data into more comprehensive groups which will permit a clearer insight into the problem of mammary carcinoma as is seen in current day practice. Therefore, the material is divided into three parts: the first, dealing with the early cases which are strictly operable, the second, with the cases in which there is extension to the supraclavicular lymph nodes and in which operation at best may be palliative, and the third with the late cases, in which dissemination is more or less generalized.

(1) The early cases include the clinical Stages I and II (Tables IV, V and VI). It is assumed that at the time of the initial examination, the carcinoma has not extended farther than the axilla, although not infrequently a more distant metastatic process without clinical demonstrability may already be present. This unsatisfactory estimation of the grade of extension of the carcinoma may help to explain to some extent the rather pronounced divergence of the results from year to year as shown in the tables, although over a period of several years, the data balance themselves and the survival curve becomes quite smooth. It may be noted that if the method of treatment consisted of a combination of surgery and radiation therapy (A I-II), 50 per cent of the cases lived five years and 42 per cent

TABLE V

B I–II. EARLY CASES IN WHICH ROENTGEN THERAPY ALONE WAS USED

Year	Total Cases	Yearly Cases	1	2	3	4	5	Per Cent	6	7	8	9	10	Per Cent	11	12	13	14	15	Per Cent
1922		2	2	2	2	2	2		2	2	2	2	2		2	2	2	2	2	
1923	3	1	1	1	1	1	1		1	1	1	1	1		1	1	1	1	1	
1924		—	—	—	—	—	—		—	—	—	—	—		—	—	—	—	3	
1925	4	1	1	1	1	1	1		1	1	1	—	—		—	—	—	3		
1926	6	2	2	2	1	1	1		1	—	—	—	—		—	—	3			
1927		—	—	—	—	—	—		—	—	—	—	—		—	3				
1928		—	—	—	—	—	—		—	—	—	—	—		3					
1929	9	3	3	2	1	1	1		1	1	—	—	3							
1930	11	2	2	2	2	2	1		1	—	—	3								
1931	12	1	1	—	—	—	—		—	—	4									
1932	14	2	2	2	2	2	2		2	5				Average 30%						
1933	15	1	1	1	1	—	—	Average 60%	9											
1934	16	1	1	1	1	1	9													
1935	23	7	6	5	5	11														
1936	25	2	2	2	17															
1937	27	2	1	21																

lived ten years. If radiation alone was used (B I-II), nearly always in those instances in which the patient was either of too advanced age or suffering from some intercurrent disease to be operable, 60 per cent of the cases lived five years and 50 per cent ten years. Finally, in the group in which no radiation therapy was given following surgery until later, when a recurrence of the carcinoma has fully developed (C I-II), 38 per cent of the cases lived five years and 33 per cent ten years.

TABLE VI

C I–II. CASES OF LOCAL RECURRENCE AFTER SURGERY IN WHICH ROENTGEN THERAPY WAS USED LATER

Year	Total Cases	Yearly Cases	1	2	3	4	5	Per Cent	6	7	8	9	10	Per Cent	11	12	13	14	15	Per Cent
1922		—	—	—	—	—	—		—	—	—	—	—		—	—	—	—	—	
1923		2	2	2	1	1	1		1	1	1	1	1		—	—	—	—	—	
1924	4	2	2	1	—	—	—		—	—	—	—	—		—	—	—	—		
1925	10	6	6	4	2	2	2		2	1	1	1	1		1	1	1			
1926	18	8	6	6	4	4	4		4	3	3	3	3		3	3	1			
1927	19	1	1	1	1	1	1		1	1	1	—	—		—	4				
1928	21	2	2	2	2	2	2		2	2	2	2	2		4					
1929	23	2	2	2	1	1	1		1	1	1	1	7							
1930	25	2	2	2	2	2	1		1	1	1	8								
1931	27	2	2	1	—	—	—		—	—	10									
1932	29	2	2	2	1	—	—		—	10										
1933	34	5	5	2	2	1	1		12											
1934	37	3	3	2	2	1	13													
1935	39	2	2	2	2	15														
1936	42	3	3	3	20															
1937	43	1	1	32																

Average 38%

Average 30%

There are certain things in this compilation which need some interpretation. Thus the surprisingly good results in Group B, where radiation therapy alone was used, must be attributed to the fact that most of the patients were of an advanced age, the average age being sixty-two years as compared to forty-eight years for Group A and fifty-one years for Group C. As clinical experience proves, the older a patient, the less malignant the growth and the longer the life span of the carcinoma. Indeed, many of the patients survived the five year period, still having the disease, and then, partly because of the generalization of the carcinoma and partly because of their old age, gradually succumbed. True enough, the ten year survival to 1928, in a limited number of cases, still represents 50 per cent, but if the next five year period is also taken into consideration, where most of the patients have already died, it is evident that in 1943 the ten year survival on a larger group of cases will amount to only about 20 per cent. It also should be mentioned that in certain cases less radical operative procedures were performed later in addition to the irradiation.

Another point in need of interpretation is the relatively high survival figures in Group C, where patients underwent the usual operative procedures, but radiation therapy was not applied until recurrence had developed which, in the greatest

majority of cases then proved inoperable. Thus the five and ten year periods of C I-II represent 38 and 33 per cent, as compared to 50 and 42 per cent respectively of the group of A I-II, in which *a priori* a combination of surgery and radiation therapy was used. This may lead one to the conclusion that it would appear safe to dispense with the prophylactic irradiation and wait until some new manifestation of the carcinoma has appeared at which time radiation therapy is instituted. A study of the time of the appearance of the recurrence shows that on the average an interval of three to four years has elapsed between operative intervention and the application of radiation therapy, a fact which would place all the cases of C I-II on a statistical equivalence of a similar interval of Group A I-II, it being assumed that the criteria of operability in both instances were originally the same. From Table IV for A I-II, we see that in the third year at least 30 per cent of the cases (by discounting the 2 per cent untraced) are already dead, so that an identical correction is in order also for Group C I-II. Furthermore, both C III and C IV-V represent comparatively much larger groups than their equivalents in the totalized A and B groups, indicating that not a negligible number of the original cases must have drifted into these groups. Undoubtedly the consideration of such factors can have no other effect than to considerably reduce the figures in C I-II, both for the five and the ten year period, as compared to the figures of A I-II. This, then, constitutes an indirect evidence for the superiority of radiation therapy in combination with surgery at the beginning of treatment of every case of mammary carcinoma. Through our systematic yearly follow-up, we were able to reach the same conclusion in a most interesting manner

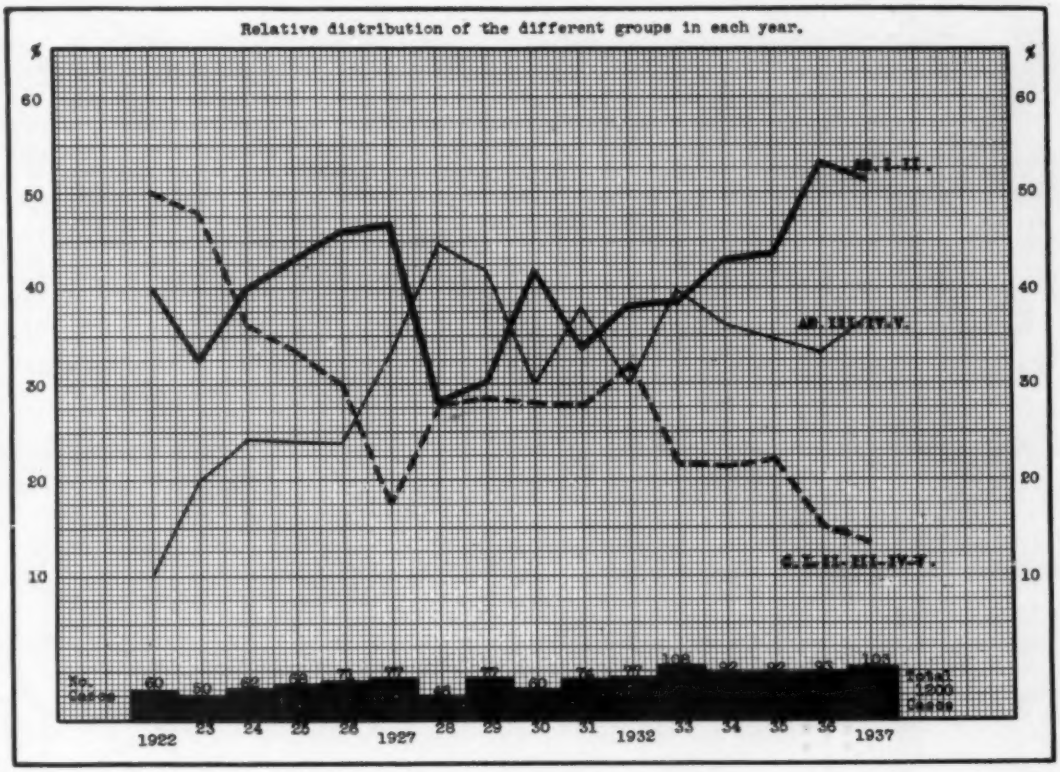

FIG. 1

TABLE VII

A III. CASES WITH SUPRACLAVICULAR METASTASES IN WHICH A COMBINATION OF SURGERY AND ROENTGEN THERAPY WAS USED

Year	Total Cases	Yearly Cases	1	2	3	4	5	Per Cent	6	7	8	9	10	Per Cent	11	12	13	14	15	Per Cent
1922		2	2	1	1	1	1		1	1	1	1	1		1	1	1	1	1	
1923	3	1	1	—	—	—	—		—	—	—	—	—		—	—	—	—	—	
1924	6	3	3	2	2	1	1		1	1	1	1	1		1	1	1	1	1	
1925	11	5	5	3	1	1	1		—	—	—	—	—		—	—	—	2		
1926	21	10	10	10	6	6	2		1	—	—	—	—		—	—	2			
1927	36	15	11	7	5	4	3		3	3	3	3	3		3	2				
1928	50	14	12	9	7	5	4		3	2	2	2	2		5					
1929	66	16	11	11	8	7	6		5	4	4	4	7	Average 14%						
1930	71	5	5	3	2	1	1		1	1	1	11								
1931	84	13	13	12	11	8	5		5	5	12									
1932	98	14	11	10	6	5	5		5	17										
1933	113	15	14	11	9	6	5		25											
1934	123	10	9	8	6	4	34	Average 30%												
1935	131	8	6	5	5	49														
1936	143	12	10	7	69															
1937	163	20	18	100																

TABLE VIII

B III. CASES WITH SUPRACLAVICULAR METASTASES IN WHICH ROENTGEN THERAPY ALONE WAS USED

Year	Total Cases	Yearly Cases	1	2	3	4	5	Per Cent	6	7	8	9	10	Per Cent	11	12	13	14	15	Per Cent
1922		2	1	1	—	—	—		—	—	—	—	—		—	—	—	—	—	
1923	5	3	3	2	2	1	1		1	1	1	1	1		1	—	—	—	—	
1924		—	—	—	—	—	—		—	—	—	—	—		—	—	—	—		
1925	7	2	2	2	—	—	—		—	—	—	—	—		—	—	—			
1926		—	—	—	—	—	—		—	—	—	—	—		—	—				
1927		—	—	—	—	—	—		—	—	—	—	—		—					
1928		—	—	—	—	—	—		—	—	—	—	—		1					
1929		—	—	—	—	—	—		—	—	—	—	1	Average 14%						
1930		—	—	—	—	—	—		—	—	—	1								
1931	10	3	1	1	1	1	1		—	—	1									
1932	11	1	1	1	—	—	—		—	1										
1933	12	1	1	1	1	1	1		1											
1934	14	2	2	2	2	1	3	Average 25%												
1935	16	2	2	1	—	4														
1936	17	1	—	—	6															
1937	18	1	1	11																

TABLE IX

C III. CASES WITH SUPRACLAVICULAR METASTASES AFTER SURGERY IN WHICH ROENTGEN THERAPY WAS USED LATER

Year	Total Cases	Yearly Cases	1	2	3	4	5	Per Cent	6	7	8	9	10	Per Cent	11	12	13	14	15	Per Cent
1922		10	10	6	3	3	3		3	3	3	2	2		2	1	1	1	1	
1923	17	7	6	3	2	2	1		—	—	—	—	—		—	—	—	—	—	
1924	24	7	7	5	4	4	4		2	2	2	2	1		1	1	1	1	1	
1925	26	2	2	1	1	1	1		1	—	—	—	—		—	—	—	2		
1926	30	4	1	—	—	—	—		—	—	—	—	—		—	—	2			
1927	35	5	4	3	2	1	—		—	—	—	—	—		—	2				
1928	40	5	4	3	2	2	2		2	2	1	1	1		3					
1929	44	4	4	3	3	2	2		2	2	2	2	4							
1930	49	5	3	3	1	1	1		1	—	—	7								
1931	53	4	3	2	2	2	2		2	2	8									
1932	56	3	2	2	2	2	1		—	11										
1933	58	2	1	1	—	—	—		13											
1934	61	3	3	2	2	—	17													
1935	64	3	2	2	—	20														
1936	65	1	1	1	24															
1937	69	4	3	37																

Average 29% — Average 10%

TABLE X

A IV–V. CASES WITH WIDESPREAD METASTASES IN WHICH A COMBINATION OF SURGERY AND ROENTGEN THERAPY WAS USED

Year	Total Cases	Yearly Cases	1	2	3	4	5	Per Cent	6	7	8	9	10	Per Cent	11	12	13	14	15	Per Cent
1922		2	1	—	—	—	—		—	—	—	—	—		—	—	—	—	—	
1923	5	3	—	—	—	—	—		—	—	—	—	—		—	—	—	—	—	
1924	10	5	4	2	1	1	1		1	—	—	—	—		—	—	—	—		
1925	16	6	2	2	2	2	2		1	1	—	—	—		—	—	—			
1926	19	3	2	—	—	—	—		—	—	—	—	—		—	—				
1927	30	11	7	7	4	3	1		1	1	—	—	—		—					
1928	34	4	2	—	—	—	—		—	—	—	—	—							
1929	41	7	4	—	—	—	—		—	—	—	—								
1930	47	6	3	2	2	1	1		1	1	1									
1931	54	7	5	1	—	—	—		—	—	1									
1932	57	3	1	1	—	—	—		—	3										
1933	66	9	7	2	1	1	1		4											
1934	76	10	4	2	2	1	6													
1935	86	10	7	6	4	9														
1936	96	10	4	1	16															
1937	102	6	4	26																

Average 9%

(Fig. 1). A compilation of the relative number of all cases of AB I-II and C I-II-III-IV-V treated since 1922 to date shows that from the start the increase of the former was followed by a corresponding decrease of the latter until 1927. In this year an important article appeared in one of the noted medical journals denying any value whatsoever in the radiation treatment of mammary carcinoma, and especially in combination with surgery. The effect of the article was immediate. Several of our surgical colleagues started to discontinue the administration of radiation therapy and the AB I-II curve took a sharp drop. Very soon, however, a corresponding increase in the curve of the C group resulted and for a few years the situation remained quite confused. Since 1931 radiation therapy has been gradually reinstated as a routine method and since then there has been a rapid increase in the AB I-II curve, followed by an equally rapid decrease of the curve of the C group.

(2) The cases of mammary carcinoma with evidence of metastases to the supraclavicular lymph nodes were formerly considered incurable and the five year mortality, without the use of radiation therapy, reached practically 100 per cent. In our series (Tables VII, VIII and IX), if a combination of surgery and radiation therapy (A III) was used, 30 per cent of the cases survived the five year and 14 per cent the ten year period. If the treatment consisted of irradiation alone (B III), the survival rates were 25 per cent for the five, and 14 per cent for the ten year period, and if the irradiation was applied later following recurrence or metastasis after surgery (C III), the figures continued to remain 29 per cent for the five and 10 per cent for the ten year period. This rather close harmony in the late results of the

TABLE XI

B IV–V. CASES WITH WIDESPREAD METASTASES IN WHICH ROENTGEN THERAPY ALONE WAS USED

Year	Total Cases	Yearly Cases	1	2	3	4	5	Per Cent	6	7	8	9	10	Per Cent	11	12	13	14	15	Per Cent
1922		—	—	—	—	—	—		—	—	—	—	—		—	—	—	—	—	
1923		3	3	—	—	—	—		—	—	—	—	—		—	—	—	—	—	
1924	10	7	3	—	—	—	—		—	—	—	—	—		—	—	—	—		
1925	13	3	2	1	1	—	—		—	—	—	—	—		—	—	—			
1926	17	4	2	1	1	—	—		—	—	—	—	—		—	—				
1927	18	1	1	—	—	—	—		—	—	—	—	—		—					
1928	20	2	1	—	—	—	—		—	—	—	—	—							
1929	29	9	4	3	2	—	—		—	—	—	—								
1930	33	4	3	2	1	—	—		—	—	—									
1931	41	8	6	1	1	—	—		—	—										
1932	46	5	4	2	—	—	—		—											
1933	63	17	12	5	2	1	—													
1934	74	11	5	4	2	1														
1935	85	11	8	4	1	2														
1936	92	7	3	1	11															
1937	102	10	7	24																

various groups furnishes, in our estimation, the best proof of the important rôle of the radiotherapeutic agent in the treatment of the regional extension of mammary carcinoma. It must be stated, however, that in many instances the patients are not free of the disease and the regional arrest of the carcinoma is of only temporary duration. This fact also explains the appears that if the carcinoma has once become generalized, radiation therapy cannot afford hope for a late survival. Nevertheless, the immediate palliative results, especially in the cases with bone metastases, are often striking and a limited prolongation of life may be expected.

The Influence of Age Distribution on the Survivals in Mammary Carcinoma. A detailed study of the effect of age distribution on the five and ten year survival curves of mammary carcinoma led to some interesting and quite significant observations.

TABLE XII

C IV–V. CASES WITH WIDESPREAD METASTASES AFTER SURGERY IN WHICH ROENTGEN THERAPY WAS USED LATER

Year	Total Cases	Yearly Cases	1	2	3	4	5	Per Cent	6	7	8	9	10	Per Cent	11	12	13	14	15	Per Cent
1922		20	13	6	2	1	1		1	—	—	—	—		—	—	—	—	—	
1923	35	15	9	5	3	2	1		1	1	1	1	1		1	1	1	1	1	
1924	48	13	8	2	1	1	—		—	—	—	—	—		—	—	—	—		
1925	63	15	8	6	3	2	1		1	1	1	1	1		1	1	1	1		
1926	72	9	9	4	—	—	—		—	—	—	—	—		—	—	2			
1927	80	8	5	4	—	—	—		—	—	—	—	—		—	2				
1928	86	6	3	3	—	1	1		1	—	—	—	—		2					
1929	102	16	12	8	5	3	2		1	1	—	—	2							
1930	112	10	8	5	4	3	3		3	3	3	2								
1931	127	15	8	3	2	1	1		1	1	5									
1932	147	20	14	3	2	1	1		1	7										
1933	164	17	10	2	1	1	—		10											
1934	177	13	7	5	4	2	11													
1935	192	15	12	6	2	18														
1936	202	10	8	2	31															
1937	210	8	7	64																

Average 7%

Average 2%

A comparative analysis of all the groups is shown in Table XIII. It may be noted that in the group which was treated by a combination of surgery and radiation therapy (A I-II) the average age was forty-eight years, whereas in the group in which recurrence followed operation and radiation therapy was given later (C I-II) it rose sharper drop between the five and the ten year survival rates as compared to the figures of the earlier cases of Stages I and II, as noted in all groups (A, B and C).

(3) The late cases of mammary carcinoma comprise Stage IV, when there is involvement by lymphatic permeation of the entire chest wall or hemithorax on the affected side and Stage V, when there is evidence of distant metastases. Less than 10 per cent of all cases, here, reached the five year and only occasional cases the ten year limit (Tables X, XI, XII). It thus

to fifty-one years. This in a remarkable manner confirms the fact which was already mentioned that the recurrent carcinomas of Group C I-II come on an average three years later to radiation therapy than would be the case if irradiation were associated immediately with surgery. In Group B I-II, the average age was—as one may expect—very high (62.5 years), since close. In the groups with supraclavicular involvement (A, B, C III) the age distribution was about the same as in the operable group and their survival curves likewise run similarly. The group with widespread metastases of the carcinoma from the beginning were not studied.

In further study of the operable group (A I-II), an attempt was made to determine

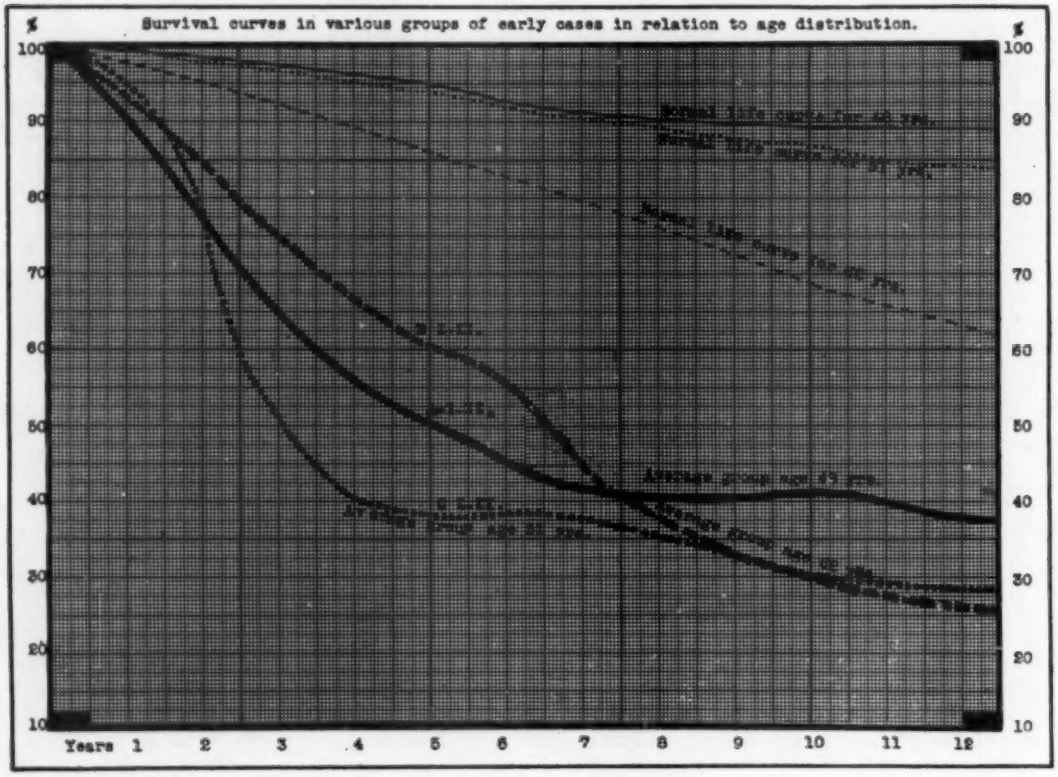

FIG. 2

radiation therapy as a primary method of treatment was usually reserved for cases which technically were operable but presented poor risks. A comparative plotting of yearly survival curves of all three groups (Fig. 2) shows that Group B, because of the more advanced average age, and thus the less malignant nature of the carcinoma, presents higher survival values up to five years, and after that the decline is rather rapid. Groups A and C run almost parallel after the lapse of the five year period, their average age being rather whether or not the various phases of life influence to any extent the survivals in mammary carcinoma. Accordingly, the patients were divided into four groups, the first including all cases up to thirty-nine years, the second from forty to forty-nine years, the third from fifty to fifty-nine years and the fourth all cases above sixty years. The average age for the cases of each group was calculated separately and then the five and ten year survivals were noted. To obtain a truer picture, the normal survivals for the respective ages were

TABLE XIII

INFLUENCE OF AGE DISTRIBUTION ON THE 5 AND 10 YEAR SURVIVALS OF TABLE III (EXCEPT STAGES IV–V)

				5 Year Survival Per Cent			10 Year Survival Per Cent		
Group	Stage	Total cases	Average age	Mammary carcinoma	Normal life	Corrected value	Mammary carcinoma	Normal life	Corrected value
A	I–II	305	48.4	50	95.2	54.8	42	88.8	53.2
B	I–II	15	62.5	60	86.0	74.0	(30)	69.0	60.1
C	I–II	34	51.0	38	94.2	43.8	33	86.8	46.2
A	III	113	49.5	30	94.7	35.3	14	87.8	26.3
B	III	12	61.8	25	86.3	38.7	14	71.0	43.0
C	III	58	50.0	27	94.9	32.1	10	88.0	22.0

also taken into consideration and corrections made. It must be stated, however, that such a procedure, although very desirable, may be used only with certain precautions. The greatest disturbing element is the fact that cancer, for example, represents with increasing age an increasingly more frequent cause of death, whereas the normal life survival curves fail to indicate the exact proportion. Thus, by making corrections in relation to the normal survival curve as a whole, the corrected figures for later ages undoubtedly appear too high. But, even by taking a middle course, it seems that three very definite conclusions may be drawn from a tabulation of our cases:

(1) In younger age, the mammary carcinoma does not have a more malignant course than in middle age. This is in contradistinction to carcinoma in other locations of the body.

(2) The poorest results in the group were obtained between the ages fifty and fifty-nine, the average being fifty-three. Thus it seems that the onset of natural menopause has no beneficial effect on the course of mammary carcinoma. This, then, tends to support the opinion that the routine roentgen castration of every case of mammary carcinoma, as so often advocated, appears a futile and valueless effort.

(3) At an older age, the malignancy of mammary carcinoma decreases with advancing years. This fact is borne out also by the observations made in connection with Group B, as already stated. It there-

TABLE XIV

AGE DISTRIBUTION OF THE 5 AND 10 YEAR SURVIVALS IN THE OPERABLE GROUP (A I–II)

			5 Year Survival Per Cent			10 Year Survival Per Cent		
Age group	Average	Cases	Mammary carcinoma	Normal life	Corrected value	Mammary carcinoma	Normal life	Corrected value
Up to 39	35	67	54	97.6	56	47	94.8	52
40–49	45	106	52	96.2	56	44	90.8	53
50–59	53	79	42	93.2	49	28	85.9	44
From 60 up	65	53	51	82.6	78	46	61.2	85

fore implies that in case of poor, or even doubtful, operative risk, one may rely on irradiation alone in treating such cases.

CONCLUSIONS

It must be stated that surgery continues to remain, as before, an important part of the treatment in carcinoma of the breast. Every case that is operable should be subjected to surgical intervention at the earliest possible moment. Even in the inoperable cases, the consideration of some sort of operation may appear necessary at any time during the course of the irradiation.

From a review of the results obtained in the above series of cases, however, one cannot escape the impression that radiation therapy has also established itself as a very powerful weapon in combating mammary carcinoma. Thus, in the early operable cases, irradiation as an adjunct method, either in preoperative or postoperative form, helps to prevent, or at least reduce, local recurrences or metastases to regional lymph nodes, and if such complications have already occurred, it helps in a great majority of cases to eradicate them. In the cases with involvement of the supraclavicular lymph nodes, radiation therapy not infrequently arrests the progression of the disease for years and although many of the patients continue to have the carcinoma, a great prolongation of life is obtained. In a smaller number of cases, especially if associated with pre-irradiation or post-irradiation surgical procedures, an apparent clinical healing with long survival may be produced. Finally, in the inoperable cases, radiation therapy constitutes the sole method of treatment. Here, often, applied in conjunction with certain adjuvants, such as preliminary intravenous lead injections, etc., it leads to marked symptomatic relief, increase in the average life span and, above all, great augmentation of the efficiency of the patient during the period of survival.

SUMMARY

The article is divided into two parts. The first represents a continuation of two former publications in 1925 and 1930, respectively, on a carefully selected series of 172 cases of mammary carcinoma between 1922 and 1924. The second contains an analysis of all treated cases of carcinoma of the breast between 1922 and 1937, the total number being 1,200 cases.

The cases were classified into three groups: A, those in which a combination of surgery and radiation therapy was used; B, those in which radiation therapy alone was applied; and C, recurrent cases following surgery in which radiation therapy was used later. According to the clinical extension, they were divided into five stages: I, local carcinoma; II, axillary extension; III, supraclavicular extension; IV, involvement of the entire anterior chest wall; and V, distant metastases.

A careful study of the cases in the first part of the paper proves that it is unwise to speak of a "carcinoma cure" even after the lapse of the five year period. Of 51 cases of the group, which were apparently well at the five year period, 16 cases died of carcinoma between the six and fifteen year periods and only 11 of other cause than cancer, 24 of the cases still being alive after fifteen years. Moreover, a local recurrence was not infrequently observed, even in cases of A I, as late as twelve to fifteen years after the treatment. Therefore, it appears that the term "carcinoma survival" is more appropriate for designation of late results.

The analysis of the 1,200 cases dealt with in the second part of the paper leads to the following results:

Five Year Survivals. Entire group (830 cases) 30 per cent; A I-II (305 cases) 50 per cent; A III (113 cases) 30 per cent; A IV-V (66 cases) 9 per cent; B I-II (15 cases) 60 per cent; B III (12 cases) 25 per cent; B IV-V (63 cases) 0 per cent; C I-II (34 cases) 38 per cent; C III (58 cases) 29 per cent; C IV-V (164 cases) 6.7 per cent.

Ten Year Survivals. Entire group (434 cases) 22 per cent; A I-II (170 cases) 42 per cent; A III (50 cases) 14 per cent; A IV-V (34 cases) 0 per cent; B I-II (6 cases)

50 per cent; B III (7 cases) 14 per cent; B IV-V (20 cases) 0 per cent; C I-II (21 cases) 33 per cent; C III (40 cases) 10 per cent; C IV-V (86 cases) 2.3 per cent.

The relation of the survivals in the various groups to age distribution is considered and some very definite observations made.

The conclusion is reached, as a whole, that radiation therapy plays a paramount rôle in the treatment of mammary carcinoma both as an adjunct to surgery in the operable and as a primary method in the inoperable cases.

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DISCUSSION

DR. EDWIN C. ERNST, St. Louis, Mo. No doubt occasionally we receive the urge to reflect whether or not our radiation therapy efforts in breast lesions and their complications are as useless as some of our surgical colleagues might have us believe. I think, therefore, the statistical data of 1,200 cases treated since 1922 is a timely presentation, especially in the direction of helping us to modify, if found wanting, our past and future radiological efforts in the management of these problems.

In analyzing these data I am placed at a disadvantage since the author probably did not have time to go into the roentgen-ray technical procedures, and the type of lead therapy employed in the treatment of their mammary cases.

The group distribution is very interesting. All of us more or less have experienced the universal tendency (the past years) towards employing radiation therapy only when recurrences have taken place. Our pre- and postoperative work immediately began to fall off after several authors questioned the value of roentgen therapy in mammary cancer, and indirectly I noticed that during the succeeding years an unusually large number of recurrent cases were brought to our attention. Practically the greater majority of our cases for a long period of time were of that type. Recently the pendulum has begun swinging back in favor of post- and preoperative therapy.

The authors have rather timely reaffirmed my beliefs as to the efficacy of certain standard radiological procedures with or without surgical intervention.

It has been equally stimulating to note that the regional lymph node extension cases of breast cancer indicated almost 100 per cent improvement in the end-results as compared with those receiving purely surgical management.

The more extensive metastatic groups with generalized lymph node extensions, usually considered more or less hopeless, also indicated that added prolongation of life with relief of many of the distressing symptoms were the rule when radiation was employed. The authors did not detail their technique, but each case individually presents so many different kinds and types of management that any fixed routine is to be avoided.

I might state that we have employed in certain hopeless cancer groups the short wave type of radiation, either the 200 kv. with heavy filtration or the 400 kv., and it seems to me that this method of application has been more than worth while in selected cases—avoiding the superimposed lung structures whenever possible.

The question of pre- and postoperative irradiation is a most difficult subject to discuss and analyze, but I am of the opinion, based on our experience, that whenever possible preoperative irradiation is given preference.

The more advanced cases, following supraclavicular surgical intervention when irradiation has been omitted, usually prove fatal. In this latter series the authors have shown that at least 30 per cent of such extensive breast involvement with radiation applications survive five years, and 14 per cent are alive ten years later. These are encouraging results. Certainly these analyses further indicate that carefully planned irradiation is anything but a worthless procedure.

The question of the possible or probable stimulating hormone influence on breast cancer

during the premenstrual period or phase has not been finally settled. I, for one, certainly feel more optimistic than Dr. Leucutia as to the value of this procedure in a limited group of cases. I am convinced that in carefully considered and selected cases there is merit in this procedure.

In conclusion I wish to emphasize certain phases of our problem. We should continue to make every effort to be helpful consultants even though at times criticisms may come our way. However, we must not overlook the fact that our consultant service must be based on the premise of having weighed all of the facts in a given case from a surgical and medical, as well as the radiological standpoint. If then we conscientiously believe that irradiation methods are indicated, it is our duty to so advise our colleagues and patients alike and continue our cooperative efforts to improve the present complete or palliative five, ten, or fifteen year end-results in the treatment of mammary cancer.

Vol. 42, No. 6

FRACTURE OF THE NECK OF THE FEMUR COMPLICATING ROENTGEN THERAPY OF OVARIAN CANCER*

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THE tendency to greater roentgen-ray dosage in the treatment of gynecological cancer has been followed by an increasing number of reports of irradiation damage to the normal tissues intervening between the site of the cancer and the roentgen tube. During the early days when only low voltages were employed, skin and superficial tissues were mainly damaged. With the advent of higher voltage roentgen therapy and corresponding increase in the dosage reaching the deeper tissues, reports of injury to the latter have been noted more often. In addition to the increase in total dosage, the time employed for the treatment was shortened. These two factors were mainly responsible for burns of the bladder and rectum complicating roentgen treatment of cancer of the cervix in the early cases of Seitz and Wintz and still occurring at present, as emphasized by the report of the Standardization Committee of the American Radium Society for 1937.[6]

Roentgen-ray injury to the bones of the pelvic girdle were not reported until 1927 when Baensch[1] of Leipzig cited 2 cases of fracture of the neck of the femur following roentgen therapy for cancer of the cervix and ovary respectively. The first case was a woman, aged forty-five, who after treatment of carcinoma of the cervix developed bilateral fractures of the neck of the femur. The second was a patient, aged sixty-two, with an ovarian malignancy; the neck of the right femur fractured two and a half years after two series of roentgen treatments had been given over large anterior, posterior and lateral pelvic fields. She died following a cerebral accident three years later. At autopsy the site of the fracture showed sclerosis of the large blood vessels, replacement of the rarefied bone by connective tissue, pseudarthrosis, but no evidence of tumor.

In 1932 Philipp[5] reported 5 cases of fracture of the neck of the femur following heavy irradiation. All of his cases were treated over large fields of the pelvis including lateral fields. In all of them there were marked skin changes. In none of his cases was there any history of trauma. Roentgen examination carried out for years following treatment showed only bone atrophy but no evidence of metastasis.

In the United States the importance of this complication was emphasized by Dalby, Jacox and Miller.[2] They reported a total of 14 cases of spontaneous fracture of the femoral neck following irradiation with 1,500 to 2,000 r over each of 4 pelvic fields, 10×15 cm., in doses of 200 r every second to fourth day. Two or three such series at intervals of three to six months were given. Serious skin damage was not observed in any of the patients. They point out that between 1931 and 1934 they observed spontaneous fracture of the neck of the femur in 10 cases out of 471, i.e. 2.1 per cent, while, in general, similar fractures occur in older women only in 1 out of 4,000–5,000.

Our reasons for adding the present case to the literature is, first, because we were able to find only 2 cases in which the diagnosis of radiation osteitis resulting in fracture of the neck of the femur was corroborated by autopsy;[1,2] and, second, to reemphasize the danger of assuming skeletal metastasis in a bone, which has been heavily irradiated, on the basis of pain, without definite roentgen evidence.

REPORT OF CASE

A woman, aged fifty-six (history No. 20824)

* From the Department of Radiotherapy and Division of Laboratories of Montefiore Hospital, New York.

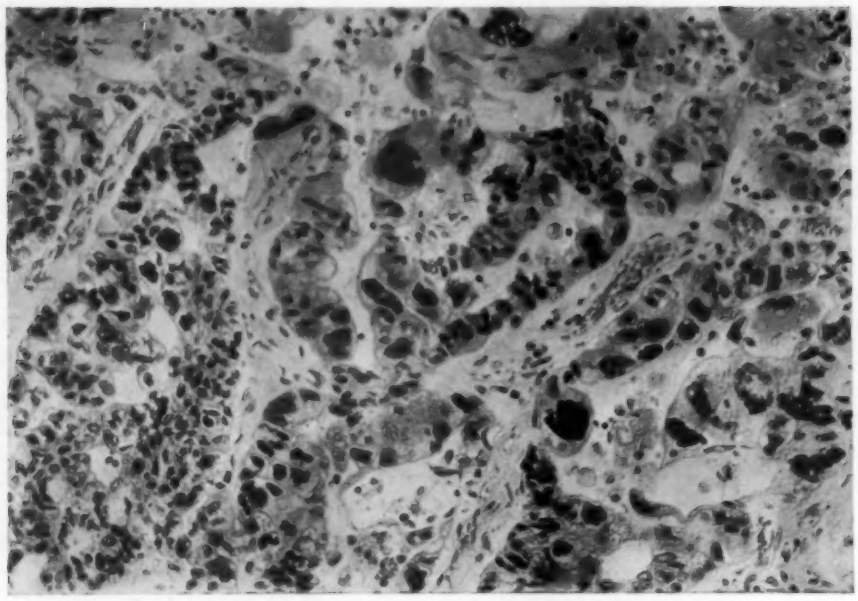

FIG. 1. Papillary adenocarcinoma of ovary (× 240).

was operated on in November, 1931, for a papillary adenocarcinoma (Fig. 1) of the ovary with metastases to the pelvic peritoneum and omentum. A right salpingo-oophorectomy was performed, and the patient was immediately referred to the department of radiotherapy at Montefiore Hospital. On admission a mass was found in the cul-de-sac adherent to the posterior vaginal wall. Roentgen therapy was given from December 16, 1931, to January 29, 1932; 2,000 r (measured in air) over each of four pelvic fields, two anterior and two posterior, each 20×15 cm., 250 r daily, 200 kv., 30 ma., 50 cm. focus-skin distance, filter 0.5 mm. Cu plus 1 mm Al. After a marked roentgen reaction of the skin and mucosa had subsided, the vaginal examination failed to reveal the mass that was originally felt.

FIG. 2. There are arthritic changes involving the right hip joint, and a small area of bone absorption is noted in the head of the right femur.

Four months after treatment the patient complained of pain radiating down the right lower extremity to the ankle. Neurological examination was negative. Roentgenograms of the spine, pelvis and the right lower extremity showed no abnormalities. A direct extension of the original lesion to the bony pelvis was suspected. Additional roentgen therapy to the right lateral pelvis was therefore given as follows: 1,000 r, field 20×18 cm., 330 r daily. Rest of technique as above. The pain, however, remained unchanged. Physical examination and roentgenograms taken during the succeeding nine months remained negative. Then there became visible a very small area of bone absorption which did not have the appearance of a metastatic lesion (Fig. 2). Involvement of the periaortic nodes was suspected. In August, 1933, the region of the lumbar spine was therefore crossfired from two fields, 1,000 r being given to each, with factors as above. As there was pain and tenderness over the right greater trochanter, which was not relieved by treatment over the lumbar region, bony metastasis in the right pelvis was suspected in spite of

negative roentgenograms. Additional 1,000 r was therefore given to each of the posterior and lateral right pelvic fields in November, 1933. Instead of improvement, however, the pain in the right thigh and back became continuous. The thigh was numb and stiff, and the patient remained home in bed for four months. On returning to the hospital in March, 1934, she showed some limitation of motion in the right hip joint, and roentgenographically, the same areas of rarefaction noted previously. Rectovaginal examination was negative. Because of the other findings, however, and the continuous pain in a patient who had had carcinoma of the ovary, the diagnosis of bone metastasis was still maintained. Follow-up roentgenograms were suggested but the patient disappeared and did not return until July 27, 1934. At this time there was clinical and roentgenographic evidence (Fig. 3) of a fracture of

FIG. 3. Roentgen appearance is that of a fracture of neck of the femur with arthritic changes in the region of the hip joint with upward displacement of the shaft. There is a possibility that this may be a pathological fracture.

FIG. 4. Roentgen appearance of the pelvis and right hip joint is unchanged.

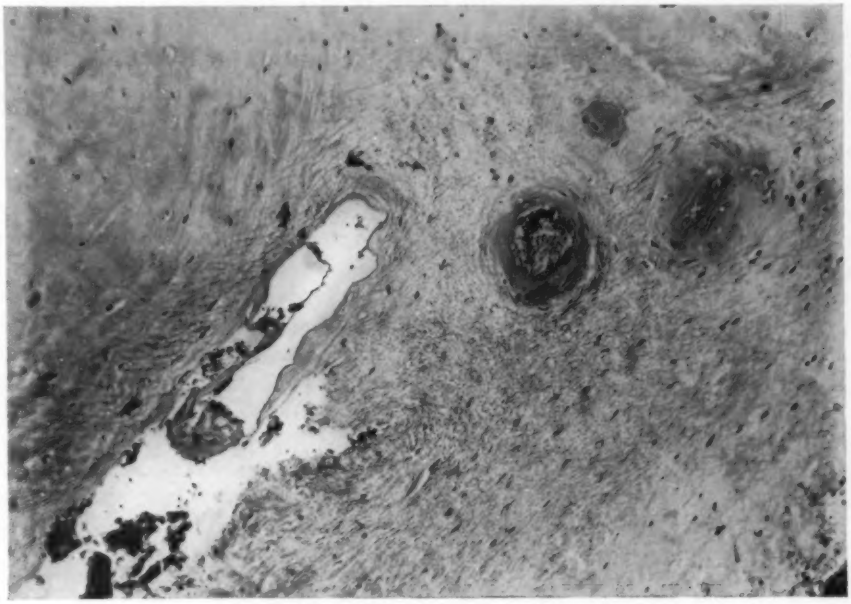

FIG. 5. Note thickening, necrosis, and obliteration of blood vessels, osteoid tissue, necrotic debris (×200).

the neck of the right femur with arthritic changes in the region of the hip joint. There was upward displacement of the shaft and the possibility that this might be a pathological fracture was considered. Two months later there were observed a moderate amount of callus, irregular areas of bone absorption and sclerosis in the region of the acetabulum. The skin showed marked induration and telangiectasia. Vaginal and rectal examinations were still negative. In December, 1934, the patient was discharged improved; she was able to walk with a cane. Follow-up roentgenograms taken within the next year (Fig. 4) showed no further changes beyond some increase in the bone absorption over the preceding films. In October, 1935, a mass appeared in the rectovaginal septum protruding into the rectum. Additional roentgen therapy was given to the pelvis posteriorly, 1,500 r to the left and 800 r to the right. The rectal mass continued to grow, and because of rectal obstruction a colostomy was performed in July, 1936. The patient gradually grew weaker and finally died in November, 1936, five years after operation, and two years after occurrence of fracture of the neck of the right femur.

A complete autopsy (No. 7171) was performed with special attention to the bone in the region of the fracture. A summary of the relevant findings follows: Careful sectioning of the bone in the region of the fracture of the neck of the right femur showed no evidence of metastasis. The bone spicules in this area were irregular with evidence of destruction along their borders. Spaces between were filled with delicate osteoid tissue containing many small blood vessels. Several large areas revealed acellular necrotic debris intermingled with fragments of absorbing bone. An adjacent region showed thick, hyalinizing, callus formation with few scattered osteoid cells. In another area adjoining, there was a thick layer of relatively acellular connective tissue contiguous with a thinner layer of granulation tissue, rich in fibroblasts and new capillaries and bordered by many osteoclasts. There was marked thickening of the walls of many blood vessels, some of which showed hyaline intimal necrosis, others complete obliteration. Isolated zones of fibrofatty tissue between bone spicules contained scattered lymphocytes, plasma, and large mononuclear cells. Tumor cells could not be identified in the many sections examined. New bone formation could not be seen (Figs. 5 and 6).

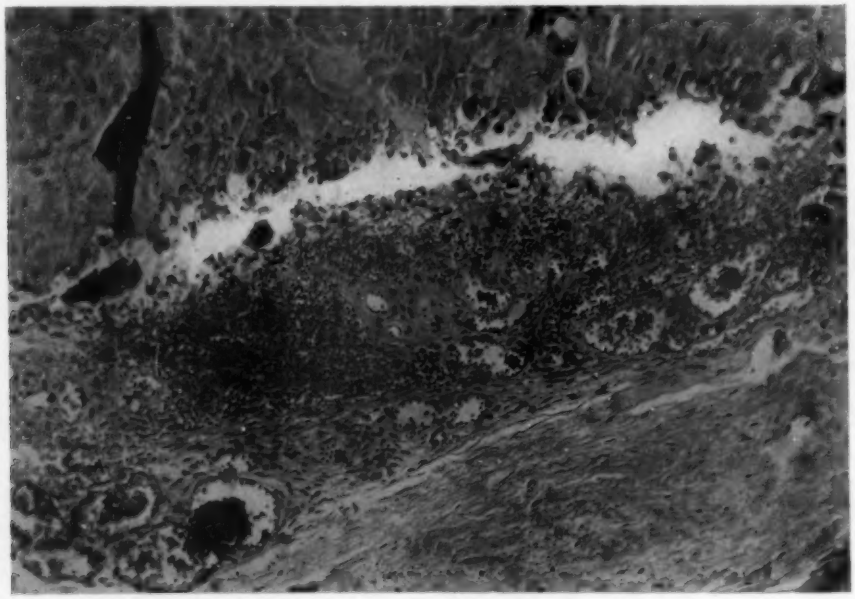

FIG. 6. Photomicrograph showing osteoclasts and granulation tissue with new capillaries at site of fracture (×200).

SUMMARY

A female, aged fifty-six, with a papillary

adenocarcinoma of the ovary was irradiated over the right pelvis during a period of one and three-quarter years because of a postoperative recurrence in the posterior cul-de-sac. The dosage was 2,000 r over the right anterior pelvis, 3,000 r over the right posterior, and 2,000 r over the right lateral pelvis. The left pelvis was also treated with 2,000 r anteriorly and posteriorly during this period. Eight months after the last irradiation to the right pelvis, and two and a half years after the first course of treatments, a fracture through the neck of the right femur occurred. In retrospect and as borne out by the autopsy findings, this could only have been due to an irradiation osteitis, and not to metastasis as originally assumed. It is well known that bone may be damaged by severe irradiation.[3,4] The blood supply here was evidently interfered with. The weight-bearing at the neck of the femur added to the stress and strain. The combination of all these factors probably accounted for the fracture.

CONCLUSION

The possibility of radiation osteitis should be remembered in patients in whom the neck of the femur is exposed to vigorous roentgen therapy in the course of treatment given to control cancer of the female genital tract.

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RADIUM THERAPY IN HODGKIN'S DISEASE

REPORT OF A CASE

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RADIUM radiation in small quantities externally applied is not often used in the treatment of Hodgkin's disease. The main object in reporting this case is to demonstrate that small quantities of radium, not more than 160 mg., is enough to produce satisfactory results even in cases where the patient suffers from enlarged lymph nodes deep in the chest, at a distance of 6 to 7 cm. from the skin surface. The low intensity of radium compared with roentgen radiation is a disadvantage in this application as the distance to skin cannot be increased very much unless large quantities of radium are used. In this case a skin distance of not more than 6 cm. was sufficient to cause large nodes situated within the chest to disappear. Therefore deep therapy was carried out.

REPORT OF CASE

A female, aged twenty-four, entered the Radium Institute in July, 1935. Since February she had observed a lymph node on the left side of the cervical region. The growth kept on developing and in September there was a large tumor twice its original size. A surgical removal of a small lymph node in the neighborhood of the large one showed on pathological examination that it was a case of Hodgkin's disease.

A roentgenogram of the chest showed multiple diffuse shadows from the third to the seventh interspace. These shadows obscured and deformed the image of the heart. The patient had therefore two areas of Hodgkin's disease: the cervical region and the nodes within the chest. The first treatment was given over the cervical region by means of an external application of radium by the use of a moulded apparatus irradiating a surface of 143 sq. cm. Distance to skin: 4 cm. Total quantity of radium: 160 mg. distributed in 16 tubes of 10 mg. each. Filter: 2 mm Pt. Total dose: 38,400 mg-hr. in ten days. The same day the treatment was finished a pigmented area was found on the cervical region and a marked diminution in size of the lymph nodes. Sixteen days later an epidermicidal reaction was observed on that area and the nodes had completely disappeared. To our surprise a roentgenogram of the chest showed that the nodes previously seen had also received a therapeutic effect and their size was

FIG. 1. First roentgenogram showing multiple shadows that obscure the image of the heart (lymph nodes).

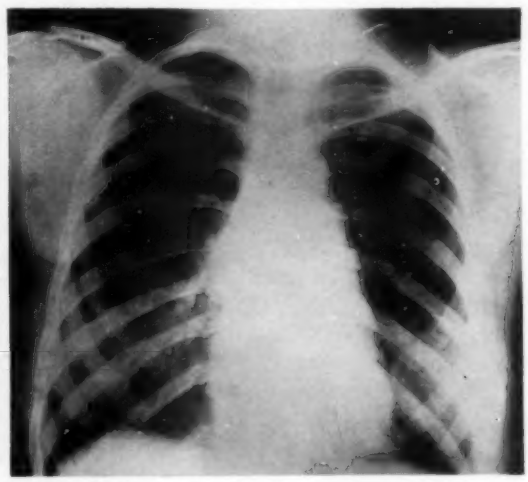

FIG. 2. Second roentgenogram after radium therapy.

markedly smaller if compared with the first roentgenogram. In order to complete the therapeutic effect of radium we finished the treatment by means of another application. On this occasion a moulded apparatus was applied on the anterior part of the chest. Surface: 81 sq. cm. Distance to the skin: 6 cm. Filter: 2 mm. Pt. Quantity of radium: 150 mg. This treatment was maintained for eight days, that is to say 2,880 mg-hr. The skin reaction from this treatment was that of an acute blistering and on this occasion the cervical skin of the left side which was not directly irradiated presented again an epidermicidal reaction, followed by a necrotic ulcer which needed six months to heal.

Figure 1 was taken before any treatment was given, and Figure 2 after the two external applications. At present eighteen months have elapsed and no other signs of enlarged lymph nodes have appeared. The general state of the patient is satisfactory but she now suffers from lumbar pains. The roentgenogram of the vertebrae shows no signs of invasion. Nevertheless a treatment with roentgen rays over this region has alleviated the pain considerably.

Comment. In this case the best results were attained by irradiating the nodes within the chest through two skin portals: one over the cervical region and the other over the anterior part of the chest. It is interesting to note that notwithstanding the great distance from the cervical region to the lower nodes within the chest there was a marked diminution in size before the second application was made.

MALIGNANT TUMORS OF THE TONGUE

A MODIFIED METHOD OF TREATMENT

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IN THE treatment of cancer of the tongue radium has always been used, and we continue to use it today, but in the form of radium puncture. The tongue is one of the few anatomical regions in which the use of puncture by radium element needles has prevailed.* This method has not been greatly modified during the past few years. My personal experience of eleven years with the treatment of cancer in general, and especially with cancer of the tongue, has given me the opportunity to use the routine methods, such as hollow needles with 2 mg. of radium filtered with 0.5 mm. of platinum. This method I have used in tumors of the tip, as well as of the middle and of the base of the tongue, varying only the length of the needles.

During the last few years I have preferred to treat cancers of the anterior third of the tongue with electrocoagulation, or, if the tumor is in the tip of the tongue, with the electric knife.

With either method I was always careful to ascertain the general condition of the patient, and to use always the best antiseptic measures in the mouth to avoid inhalation pneumonia, particularly when the condition is accompanied by trismus.

I have never used radon, either gold seeds or bare tubes, because in Rio de Janeiro it is not available, and so I had to limit myself to the use of radium element.

Lately, I have abandoned the method of radium puncture, because I observed the extreme difficulty with which patients are able to hold needles in the tongue for twenty-four or forty-eight hours. The extreme mobility of the tongue is a factor which renders it difficult to keep the needles *in situ*. Another reason which induced me to abandon this method was the fact that the necrosis produced around the needles prevented keeping them firmly in position, thereby endangering a satisfactory result, because of improper distribution of radiation, and increasing the possibility of accidental deglutition of the needles by the patient.

* Von Dollinger da Graça. Estado actual da therapeutica do cancer. Memoria a'o 1° centenario da Academia Nacional de Medicina do Rio de Janeiro, 1928.

MY METHOD

I make a groove at the site of the growth by means of the electric knife. The use of the electric knife has the advantage of destroying the bulk of the tumor, and favoring asepsis of the procedure. I place the radium in a platinum capsule of 0.5 mm. wall thickness, and place this capsule into the groove, holding it in place by means of two or three silk stitches. Besides these stitches, the capsule carries two silk threads, one of which is attached to the outside and the other to the tongue. I have observed that the patient endures less suffering with this procedure. I have also observed that the radium is held in place in a much more satisfactory way, in spite of the necrosis. At the end of four to five days I cut the stitches which held the tubes in place. In removing them I observe that, since they were inserted 0.5 cm. beyond the edge of the growth, they have not been greatly affected by the necrotic process.

I have observed very good results from this method. Healing takes place in a period of from fifteen to twenty days.

The idea which has inspired the development of this method has been to benefit the patient by the radium application and at the same time to spare him, so far as possible, the suffering attending the puncture method.

In dealing with the metastasis to the cervical lymph nodes I continue to use the approved scientific methods at present in use such as radium pack, deep roentgen therapy and surgery.

Vol. 42, No. 6

VASCULARIZATION OF THE BROWN-PEARCE RABBIT EPITHELIOMA TRANSPLANT AS SEEN IN THE TRANSPARENT EAR CHAMBER*†

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THE readiness with which metastatic tumor cells grow in tissues distant from the original site is dependent to a great extent upon their ability to maintain their nutrition by developing a blood supply in their new location. It seems of some moment to study the development of the vascular supply to a tumor transplant placed in a rabbit ear chamber, and particularly to find out if possible whether the pattern of the vascular response to the transplanted tumor tissue resembles that of other transplanted tissues and repair reactions. These data are to be used as controls for a study of the effects of roentgen radiation upon the blood vessels of the tumor transplant which follows in another paper of this series.

Sandison, and Clark and coworkers[1-5] have studied the growth of various living tissues including the development of blood vessels by inserting various types of chambers in the rabbit's ear. Since the tumor transplant develops so rapidly in the ear chamber, a simple transparent chamber was used in our study rather than the more complicated and technically difficult procedure developed by Clark *et al.*

The tumor chosen for our investigations was the Brown-Pearce rabbit epithelioma. This tumor in our laboratory had an extremely high percentage of takes by the testicular fragment inoculation method (about 98 per cent). The tumor did not grow as well in the rabbit's ear as in the testes, but it did take in a sufficiently high percentage of cases (56 per cent) to make it practical for microscopic study. Metastases from ear inoculations have never been noted in our experience (122 cases) although they occur in almost every case following testicular transplantation. If the transplant takes, growth is rapid and uniform until the window area is filled; then regression occurs. The vascularization of the newly transplanted tumor fragment from the time of implantation up to the time that tumor growth is definitely established is the main concern of this study.

Since the ear is a specialized organ in the rabbit, blood vessel distribution differs in some respects from that of other organisms. Yet these vessels in their responses to stimuli (especially those stimuli presented by foreign material or by the tumor transplant) should follow the fundamental reactions of blood vessels generally. It was felt that the tumor transplant in the ear could be considered as an analogue to a tumor metastasis in most respects. In brief, our experiments show that the vascular response to the tumor transplant has no unusual or specific characteristic except for the extremely rapid development of the vessels for it utilizes and amplifies the loop and anastomoses configurations so thoroughly described by Clark and his coworkers in their study of normal repair. The gross vessel pattern of the Brown-Pearce rabbit epithelioma is much like that shown by Lewis[6] for the mouse tumors having little stroma (fibrosarcoma, spindle, and round cell sarcoma, and to some extent adenocarcinoma), but is quite different from the adenofibroma. The step by step observations of the developing vascular bed have been of great interest. Since the technique is rather meticulous, it is described in some detail.

METHOD

Young, well-developed, adult, male rabbits of susceptible stock were used throughout these

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† Aided by a grant from the Donner Foundation.
‡ Deceased, June 3, 1937.

FIG. 1. View of microscope mechanical stage showing method by which window is held in position during observation. The soft sponge-rubber legs are placed on both sides of the holding plate for convenience in use. The purpose of the plate is to flatten the ear out gently. If the rabbit moves, the ear slips out from under smoothly, with little trauma.

experiments. The windows were made from ordinary clear, colorless "x-ray film" (cellulose acetate base) from which the emulsion had been washed. During the earlier part of this study, one of us (A. G. Ide) used the flat window for both sides of the ear (82 cases). A later modification (N. H. Baker) produced a moulded window which would provide space approximately 3 mm. deep by 1 cm. across in which the tumor might grow in a deeper chamber containing plasma (40 cases). The moulding was done by placing a square of film between the ends of the two brass cylinders, one of which had a small mound-like elevation (flat top, 1 cm. in diameter, 3 mm. above the base) and the other a corresponding depression. The whole apparatus was immersed in boiling water for a few minutes to soften the film, and the brass mould pressed firmly together. The film was set in its new shape by plunging it into cold water.

The animal's ear was epilated by the usual barium sulfide mixture. Novocaine infiltration at the base of the ear was used for the operation which was done with aseptic precautions. An area of about 1 cm. square was marked off near the tip of the ear between the central and marginal vessels. The skin was carefully dissected off the outer and inner surfaces. Hemorrhage, which may accompany the operation, was readily controlled by compressing the area between the gauze-wrapped fingers for three or four minutes. A small piece of tumor tissue approximately 1×1×1 mm. was placed on the exposed area of the outer surface of the ear. This area was rimmed with collodion and the flat, clear film, or a moulded window placed over it. Except for the tumor transplant, the inner side of the ear was covered in the same fashion with a flat window. The two windows were then sutured into place by a continuous through and through silk suture. The moulded space below the outer window filled within the next four to eight hours with exuded serum and red blood cells providing a good nutritive medium for the transplant.

Some controls were treated in exactly the same manner except that the tumor transplant was omitted. The chamber was observed to determine the vascular response to the operative procedure. In other controls, small pieces of liver, rectus muscle, or skin were transplanted beneath the windows.

The Brown-Pearce rabbit epithelioma was carried along by testicular inoculation in stock animals. For ear transplants fresh, rapidly growing, firm grayish stock tumor tissue was obtained from testes in which the tumor had been previously implanted two to four weeks past. In some cases suitable tumor tissue was secured from small metastatic nodules of recent origin, preferably in the liver, or if there were no liver nodules, from metastases into subcutaneous tissue. Experience has shown that only such actively growing tumor tissue grows well in the ear.

In order to follow the progress of the growth of tumor and vessels in the chamber, unnarcotized rabbits were trained to lie quietly on a specially devised animal board. The ear containing the transparent chamber was centered on a movable brass plate fixed to a microscope stage (Fig. 1). This brass plate had a large central hole for the transmission of light. A thin brass ring with short soft rubber legs was placed carefully upon the ear over the transparent chamber, and was fixed by two bolts to the plate on which the ear rested. This device held the ear steady and flat with but gentle

pressure and did not impede the circulation. Observations were made at frequent intervals and photomicrographs were taken for permanent records.

Several sources of light were used. A 500 watt projection bulb was satisfactory for most purposes. The most efficient, however, for prolonged study was a recently developed mercury capillary bulb.* The light from this mercury bulb is rich in the blue and the green, and is almost devoid of radiation in the red and infrared ranges so that there is no necessity for a heat absorbing device in the path of the light rays. In general, observations under high magnification were obscured by scattered light because of the thickness of the section between the windows, but even so sufficient data concerning the development and growth of the vessels and tumor cells were obtained to warrant the use of this technique.

CONTROL STUDIES

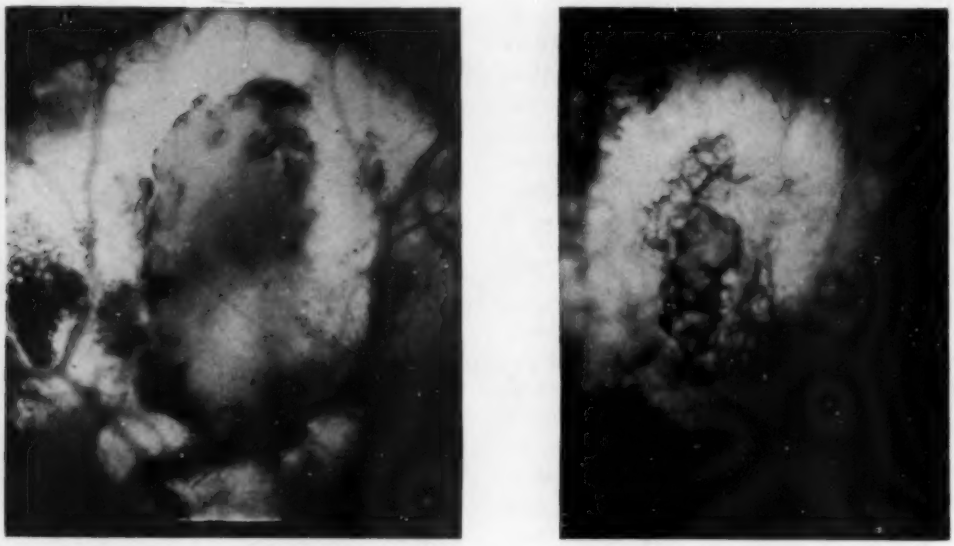
New vessel formation was evident first at the periphery of the window on about the sixth to the eighth day. This corresponds well with the observations of Clark *et al.*[1-5] who used a round table in the chamber and observed new vessels first growing onto the table five to nine days postoperatively. With our type of chamber the entire area contained preformed vessels upon the perichondrium from which it was possible for new vessels to have their genesis. However, in each case the more prominent of the new vessels grew out from the severed vessels at the edge of the window.

In comparison with the tumor-bearing ear, the control site (no transplant) showed a relative paucity of the smallest vessels, i.e., arterioles and venules (Fig. 2). There was no characteristic pattern of the vessels. They grew haphazardly with the loops and anastomoses and branches much as described by Clark *et al.*, gradually extending from the periphery toward the center of the chamber, as might be expected. Arterioles and venules were the most prominent features in the normal chamber. When venous return was momentarily obstructed by pressure at the base of the ear, a moderately rich, normal looking anastomotic capillary network could be demonstrated. The arterioles and venules showed the arrhythmic and spontaneous emptying and filling of the normal circulation and seemed to react in a normal manner. Since hemorrhage was a rare occurrence in the control ears, these new vessels under the window were rather sturdy. In general, the reactions were not fundamentally different from those described by Clark *et al.*

Fig. 2 (40×). Control chamber without transplant eight days postoperatively. A few new vessels have started growing at the periphery of the window. The larger vessels are normal for the perichondrium.

Chamber with Tissue Transplants. Control tissue transplants were observed under the same conditions and illustrated the profound lack of ability of normal tissues to stimulate blood vessel growth quickly enough to maintain growth in this type of acute experiment in contrast to the rapid growth of vessels called forth by the tumor transplant. A small piece of liver 1×1×1 mm. was put in a flat chamber in the same manner as was the tumor. On the sixth day postoperatively a vascular response was

* This was very kindly loaned by Dr. W. I. Whitney of the General Electric Company, Research Laboratory, Schenectady, New York.



A *B*

FIG. 3. *A*, three days after transplantation, showing an increase in the number of very small vessels at the periphery of the chamber and no new ones near the liver fragment. *B*, nine days after transplantation. The fragment of liver has been partially absorbed. Small blood vessels have entered the stroma of the residue following somewhat the original pattern of the liver vessels if not actually connecting up with some of them. No large vessels seem to be contributing blood to the fragment.

observed around the edge of this tissue (Fig. 3). This initial vascular reaction did not increase nor was it maintained. The liver fragment was slowly absorbed and on the fourteenth day postoperatively all that remained was the pattern of the original stroma. Typical new vessels were seen growing in from the edge of the chamber just as in the simple control chamber. A speedy vascularization seemed to be initiated by the liver tissue but it was not maintained nor did it approach the sustained rapidity of development of the profuse vascularity seen around and in tumor transplants. Skin which was transplanted into the chamber and which also failed to take likewise elicited no sustained vascular response. These experiments were repeated seven times using liver, four times using skin, and twice using kidney as the control tissue without a successful "take," probably due to the lack in our acute experiment of the well established vascular supply which is present in the more prolonged experiments reported by Clark *et al.*

Chamber with Tumor Transplant. Vessel growth about the tumor transplant made its first appearance in from three to eight days following inoculation. The first response (within the first seventy-two hours of transplantation) consisted in either widening of pre-existing vascular channels or else a proliferation of small vessels mostly from the severed ends of the wider parent stems at the margin of the window. In any event, small blood vessels (the majority being larger than ordinary capillaries) increased in number at a very short distance from the tumor edge. Within the next twenty-four hours, these vessels could be seen within the growing margin of the tumor substance (Fig. 4), and from this point on the tumor itself increased markedly in size. Some of these vessels within the growing edge may not attain the caliber of venules and often remain considerably smaller than normal arterioles. Others may become quite large. Isolated capillary loops may develop outside the tumor edge but within the tumor they were the exception rather than the rule. The manner of development of those capillaries which ap-

peared at the tumor margin differed in no way from the manner of development described by Sandison[1,3]. New capillary loops were preceded by a narrow line of packed erythrocytes which were mostly within the lumen of the capillary bud although some may have extruded from the distended capillary tip. These packed erythrocytes could frequently be seen pulsating. A considerable volume of the growing tumor is supplied by small vessels of the same general caliber normally having such a uniform pattern of anastomoses as to suggest a series of ladders placed side by side (Figs. 5 and 6). One of the most characteristic features of the larger vessel pattern was its arrangement at the periphery of the tumor mass. This pattern can be described as corona-like for all the vessels from the surrounding structures seemed to be directed at the tumor like the spokes of a wheel. This was best observed under low magnification when the fragment was rapidly growing and had not yet filled the chamber (Fig. 7). The anastomoses between the large adjoining radial vessels were very numerous at the periphery of the tumor near the growing edge.

Near the center of the tumor at the site of the original fragment or transplant, the

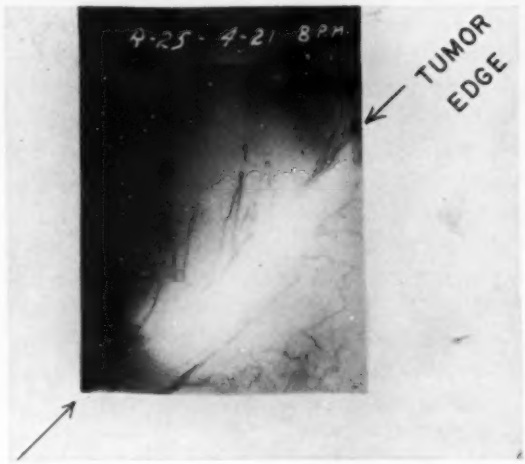


Fig. 4. (50×) Growing edge of tumor (dark) eight days after implantation showing the loops and buds invading the margin from the area around the tumor (light).

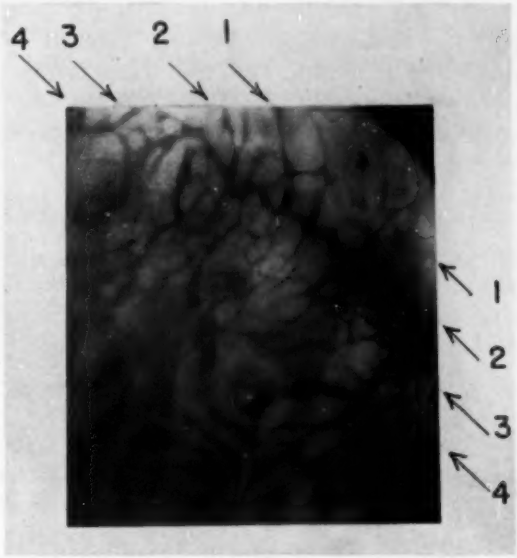


Fig. 5. (50×) Four days after transplantation showing four progressive stages of lateral anastomoses which have developed as the tumor grew upward and to the right within the previous two days. The dim lower half (and to the left) is part of the edge of the original transplant. The first two levels (*4* and *3*) are not well defined as the No. *2* connections which were at one time like the edge shown in Figure 6. At the time of the present photograph the No. *1* level is just behind the advancing edge of the tumor. This level later became much more evident as the blood flow through it increased.

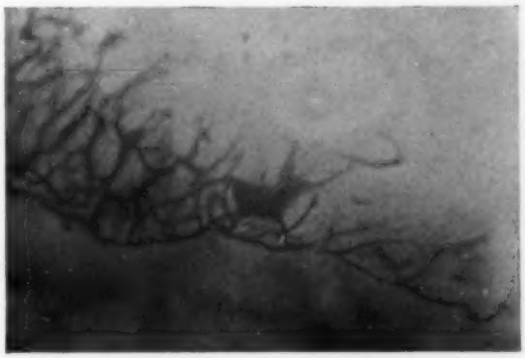


Fig. 6. (40×) Ten days after transplantation showing the growing edge of the tumor outlined by the anastomosis of many small vessels. Above this within the tumor may be seen the previous levels of similar anastomoses. The tumor is advancing downward to the left into the darker area. This darkness is due to masses of red blood cells and large vessels in the background.

vessels appeared to fade away, in keeping with the tendency of this tumor to suffer central necrosis and to exhibit centrifugal growth. As the fragment expanded, the more abundant, new, anastomoses grew centrifugally while those vessels in the older portion of the tumor were seen to diminish in apparent number. Yet if the venous drainage of the chamber was ob-

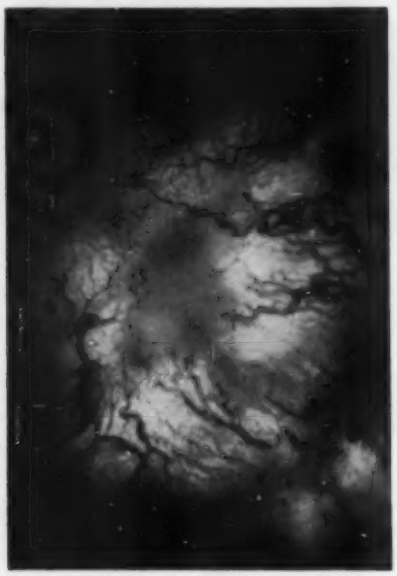


FIG. 7. Low power (20×) of tumor and vessels eight days after implantation. The dark center is the original remnant. The roughly circular outline is the border of the growing edge of the tumor which practically fills the chamber. The radial distribution of the vessels, originally contributing to the center, now anastomosing and contributing blood to the whole tumor mass is well illustrated. Compare the vascularity with the controls (Figs. 2 and 3).

structed by compression at the base of the ear the central portion of the tumor still showed a rich network of small and large vessels, but as soon as pressure was released the previous central ischemia supervened. This suggests that the vessels were kept empty by pressure and that they were not closed off nor destroyed at this stage at least.

The tumor fragment had a definite scheme of growth in the different chambers. In the flat chamber the growth of the tumor was almost all lateral, as might be expected. In the deep chamber no observable change took place in the size of the tumor fragment until the vessels began to proliferate; immediately thereafter one could detect expansion. The tumor very quickly increased in thickness until the top of the chamber was reached, but from that time growth proceeded laterally only. The extreme rapidity of growth limited the time in which the chamber could be profitably studied. A week of growth would fill the moulded chamber completely with tumor. Thereafter a new factor was brought into play, namely pressure and consequent pressure necrosis. The chief effect of pressure on the vessels was to keep them empty, hence useless for study and observations. The thickness of the chamber precludes the use of oil immersion studies so that to see the vessels they must have some erythrocytes in them. The force exerted by the growing tumor was sufficient in some cases to separate the window from the ear. Frequently the tumor literally "killed itself" by expansion within the closed space.

After the tumor had grown and later regressed or necrosed, the animal often became refractory to intratesticular inoculation. In a series of 31 such animals, 22 (71 per cent) showed no take when inoculated from one to three times intratesticularly with a tumor fragment. When the characteristic vascular reaction to tumor failed to occur and the tumor did not grow, the animals developed takes on subsequent intratesticular inoculation. It has been pointed out by many observers that an inoculum of dead tumor tissue does not stimulate a refractory state but that the tumor must grow for a time before regression.

After the period devoted to observation had passed, the chamber was removed from the rabbit's ear, fixed, sectioned, and stained in the usual manner for microscopic study. If the window was not removed for several weeks after the tumor had ceased expanding, the chamber became extremely dense; microscopic examination of the stained section of the whole

area failed to reveal the presence of any tumor cells, only scar and debris and vessels remaining to record its passing. Where the tumor did not take at all, one saw in the histological preparation normal structures of the rabbit's ear with the addition of a little scar tissue from the operative procedure. The epithelium had covered the operative area in the usual time. The resemblance here to the control studies in which substances other than tumor were transplanted was striking. If the tumor took well, and was still active at the time of biopsy, the usual extremely cellular neoplasm with great numbers of mitotic figures was found in the fixed section. The mass of tumor was usually thicker in the deeper chamber; otherwise the vessel and tumor characteristics were essentially the same. The tumor grew in practically a solid mass or sheet with little or no supporting connective tissue stroma. There were large numbers of vessels, many full of red cells. These vessels were usually larger and more numerous in and around the base of the tumor, close to the cartilage but were few in number in the center of the tumor. This was especially true in the deeper chamber. Practically always the central portion of the tumor showed degenerating cells, necrosis, and hyalinization in the fixed tumor specimen. This was in keeping with the picture seen in this tumor taken from other sites.

In the event of total resorption of a well developed tumor mass, the section showed a marked increase in subcutaneous connective tissue and a localized dense infiltration with large mononuclears and small round cells at the tumor site. The window area had been covered by epithelium which was thicker than normal (i.e., controls) over the tumor site and at the chamber margin. The blood vessels appeared to have much the same size as in the simple control ear chamber although they were much more numerous.

DISCUSSION

Vessel growth in the control ear is essentially a reparative process. Many of the fields viewed and photographed show numerous tiny vessels shooting off from relatively wide ones without the interposition of vessels of an intermediate size (Clark *et al.*). Many of the new vessels have not persisted throughout the period of observation (see Clark also). In our experiments when a "control" tissue other than the tumor (liver, muscle, etc.) is placed in the chamber, the vascular response does not differ greatly from that seen in the control ear, probably because none of these tissues seem to grow in this site where the blood supply was undeveloped as yet and therefore inadequate to support growth. Clark has had no difficulty in growing fragments of tissue in his type of chamber when the transplantation is performed after the "repair" stage is past and a good blood supply developed in the site. In other words, the bed is prepared for the tissue to grow in. In our type of acute experiment the bed is in no sense prepared for the control tissue and it is unable to survive until the proper conditions for its growth are available. By contrast, the rapid blood vessel growth toward and into the tumor transplant is very striking, especially in the absence of any preparation of the site. The inference to be derived from this is that for any considerable stimulation of vessel growth it is necessary that the "foreign tissue" grow for a time and in any case it is a restrained slow vessel proliferation. There is, however, some difference to be noted. Inasmuch as the foreign tissue was of absorbable material, it stimulated a local hyperemia which persisted until the foreign tissue was phagocytosed. From the size and arrangement of the vessels noted about the control transplant it is probable that most of them were already present and left undisturbed by the operation but in an empty or collapsed state and were not newly formed. As the wound heals with the ultimate formation of scar tissue, these vessels empty or collapse again (perhaps shrink also) and the ear resumes its normal, less vascular appearance.

When the tumor fragment can grow

freely the gross blood vessel response is such that it may be identified at a glance. The pattern of the vessels leading into the proliferating tumor may be described as radial, coronal, spoke-wheel, and so on. The vessels at first invaded the tumor from the periphery but as soon as the fragment began expanding the vessels advanced along with and near the advancing growing edges. In the deep chamber, extrinsic vessels which originally grew to the tumor edge were soon overgrown by the tumor. As the tumor fragment became globular, vessels extended up from below, encircled and grew over the top much like the fingers of a hand grasping some bulky object.

The identity or classification of the "terminal" vessel or "capillary" in the tumor mass is difficult. The smallest vessels are too large to be ordinary capillaries since they are anywhere from 5 to 500 red blood cells in diameter. Blood flow may be very rapid in them and one frequently notes a reversal of the direction of blood flow so that they readily form pathways for the transference of arterial pressure to the venous circulation. These vessels occasionally exhibit marked variations in lumen size along their course, almost like a series of hour-glasses strung together.

Normal contractility of the new tumor vessels is extremely difficult to demonstrate. Unless the rabbit is stimulated in some fashion, these vessels are seen to empty and fill but actual contractility has not been visualized. When the animal is frightened, there is a general reduction of blood flow in all of the vessels of both ears but the flow is re-established much more quickly in the tumor vessels than in the vessels in the chamber of the control ears and elsewhere. This diminished response in contractility may in some manner be related to some specific characteristic of the rapidly growing tumor or what is more likely it may be due to the fact that these vessels are mainly simple endothelial tubes and lack some of the normal vessel structures.

These vessels form no permanent pattern within the tumor although the arrangement at the growing edge is so uniform and striking as to be recognized at a glance. There are more patent vessels at the growing edge of the tumor than elsewhere. The tumor is a constantly changing environment to which these vessels must respond fairly rapidly so that as growth proceeds, the local demand for blood changes and many of the anastomotic loops become inactive and empty. In the central portion the blood flow through the previously abundant plexus soon diminishes so that only a very few vessels can be seen in the center as the periphery moves outward. This is repeated over and over as the tumor moves toward the limiting walls of the chamber. After a time, tumor and vessels become hyalinized so that the earlier plexus disappears in part or entirely. If left alone long enough the tumor will grow until probably the pressure within the chamber walls forces the greater portion of vessels to collapse and the tumor dies. Such a mechanism may operate in other sites of tumor growth with equal ease.

The vessels in the tumor are extremely fragile. Even large ones seem to have no other wall than the endothelium. Often a slight jar will cause enough hemorrhage to obscure a whole chamber. This had added further difficulty to studying these vessels, since with prolonged observation, the heat from an ordinary light source may be enough to rupture many of the vessels. This vessel fragility is much more pronounced in the tumor than in the control areas. In the latter, the vessels are relatively resistant to rupture even though subjected to considerable trauma. To obviate this difficulty it is important to train the animal to lie quietly for a considerable period of time. This may be done before hand and during the three or four days after operation while the chamber is clearing.

The vascular response to the repair reactions of the controls without transplants is geared to a much slower rate than that to the tumor. The lack of growth of the

transplanted control tissues may be responsible for the failure of the development of a definite vascular response in their case, and vice versa. The fact that the tumor is an extremely actively growing tissue may be one of the factors in evoking the vascular response. The fundamentals of vessel development in detail are not abnormal since the vessels develop by means of the normal principles described by Clark *et al.* The pattern of their development is determined probably by the physical characteristics of the experiment, i.e., the demand of the tumor and to a certain extent the spacing of the chamber.

Upon consideration of the speed of growth of the tumor the abundance of vessels in the tumor area as opposed to the nontumor bearing area and control windows, and the richer anastomotic network at the growing edge of the tumor in contrast to its central portion, one is almost forced to the conclusion that there is associated with the viable growing tumor cells some blood vessel growth stimulating factor. It must be utilized rapidly *in situ*, for otherwise by diffusion it would stimulate vessel proliferation over a much wider area than is actually affected.

SUMMARY

1. A simple technique is described for the study of blood vessel growth about a fragment of the Brown-Pearce rabbit epithelioma transplanted into a transparent chamber inserted in the rabbit's ear (resembling a modified Clark window).

2. There are 56 per cent takes in the ear chamber as compared with 98 per cent takes with testicular inoculation of this tumor.

3. Blood vessel growth around the tumor transplant is first noted in from three to eight days following transplantation.

4. Tumor growth is grossly visible within twenty-four hours following the beginning of visible blood vessel growth.

5. If blood vessel growth is not observed, the transplant fails to take as shown by subsequent biopsy.

6. The tumors grow to the chamber limits and then suffer complete or partial resorption.

7. Following resorption of tumor which has grown in the ear chamber, about 70 per cent of the animals are refractory to subsequent intratesticular inoculation.

8. Blood vessel growth is orderly and characteristic, following a definite corona-like arrangement not observed in any controls. All the normal mechanisms of blood vessel growth (buds, loops, anastomoses) are found but the speed of development is greatly increased over that of the controls.

9. Since the rapidly growing tumor tissue is able to initiate in an unprepared site an adequate blood supply which is characteristic in pattern and not observed in the controls and the repair sites, it is probable that the tumor may be elaborating a vessel growth stimulating substance.

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RADIUM QUANTITY METER*

By ROBERT B. TAFT, M.D., B.S., M.A.
CHARLESTON, SOUTH CAROLINA

WHILE the determination of the number of milligrams of radium in any given container is an everyday procedure in many laboratories equipped for that work, it still necessitates a certain amount of calculation which would prohibit its use in the average clinical department.

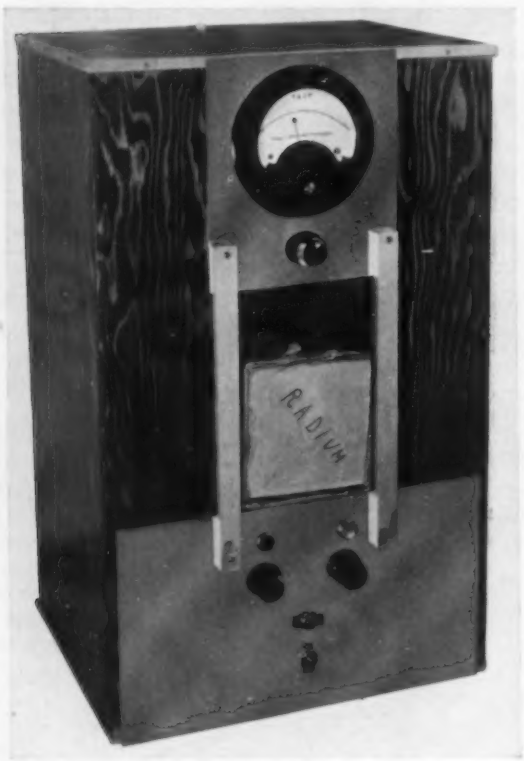

FIG. 1

However, it seems that if an easily operated machine could be obtained by which any technician could determine the amount of radium contained in a sealed mailing carton, pack or bandage, much worry could be avoided.

Having tried many systems over a period of some years, I believe that I have an instrument which answers all the requirements for radium check-up purposes, though, of course, the accuracy expected is not as great as that obtained where more painstaking methods are used. No timing or calculations are involved, the meter being calibrated in milligrams.

Of no small importance is the fact that this instrument employs no delicate or unusual parts such as special vacuum tubes or highly sensitive meters and that no batteries are used. All materials are ordinary radio and electrical merchandise.

As shown in Figures 1 and 2, the apparatus consists of a pair of ionization chambers and a single tube amplifier which allows the ionization current to be read on a meter in terms of milligrams. In this instrument, two scales are available, 0–50 mg., and 0–100 mg. For the convenience of the unskilled operator, one scale is drawn in red and the other in green, pilot lights (not shown in the diagram) of corresponding colors indicating which scale is being used. Two chambers of rather large size are used so that the effects of distance and centering are minimized.

The chambers are made of tin (tinned iron) of 0.010 inch thickness and the dimensions are $20\frac{1}{4} \times 9 \times 3\frac{1}{2}$ inches and are charged to a positive potential of 400 volts. Inside of each is one plate of the same material $17 \times 8\frac{1}{2}$ inches supported on amber posts and connected to the grid of the 6J7 tube. Each chamber is inclosed in a box of $\frac{1}{4}$ inch plywood for electrical protection and the two boxes are mounted so that there is a clearance of $4\frac{1}{2}$ inches between them.

The amplifier tube is the ordinary 6J7 which gives ample magnification of the feeble ionization current, provided the factors used in its hook-up are properly arranged. Plate voltage is 400 and screen voltage 90. Grid leak 1,000 megohms. Correct bias is obtained by grounding the cathode and suppressor through a 2,500

* Read at the Thirty-ninth Annual Meeting, American Roentgen Ray Society, Atlantic City, N.J., Sept. 20–23, 1938.

ohm resistor. As this entire circuit depends on the characteristics of one tube, several should be tried until the best one is found, the tubes of different manufacturers differing considerably.

When a new tube is first placed in the circuit, the meter should be shunted allowing the set to work normally for about thirty minutes, as apparently this much ageing is necessary to the performance of the tube. During this time the plate current may rise high enough to injure the meter if the precaution of shorting is not taken.

The meter is preferably a low resistance microammeter and is shunted by an external resistor so that the total scale is about 250 microamperes.

When there is no ionization current flowing from the chambers, there is always a base current in the plate circuit. This may be bucked to zero by a single cell battery but the battery can be eliminated by using the electronic emission from a radio tube of heater type as previously shown.[1] As the electronic emission continues for some seconds after the main switch is cut off, the meter would ordinarily be swung violently backward, but this is prevented by using a double throw line switch (not shown in the diagram) which shorts the meter when the line switch is turned off.

A variable resistor in series with the bucking tube enables the plate current of the amplifier to be exactly neutralized and thus the meter brought to zero, although the amplifier is passing about 1 milliampere.

Line voltage fluctuations are practically eliminated by the use of the Raytheon automatic voltage regulator.

The matter of filtration of the radium samples is an important one. If the chambers were made of thick lead, the differences in readings caused by different filtra-

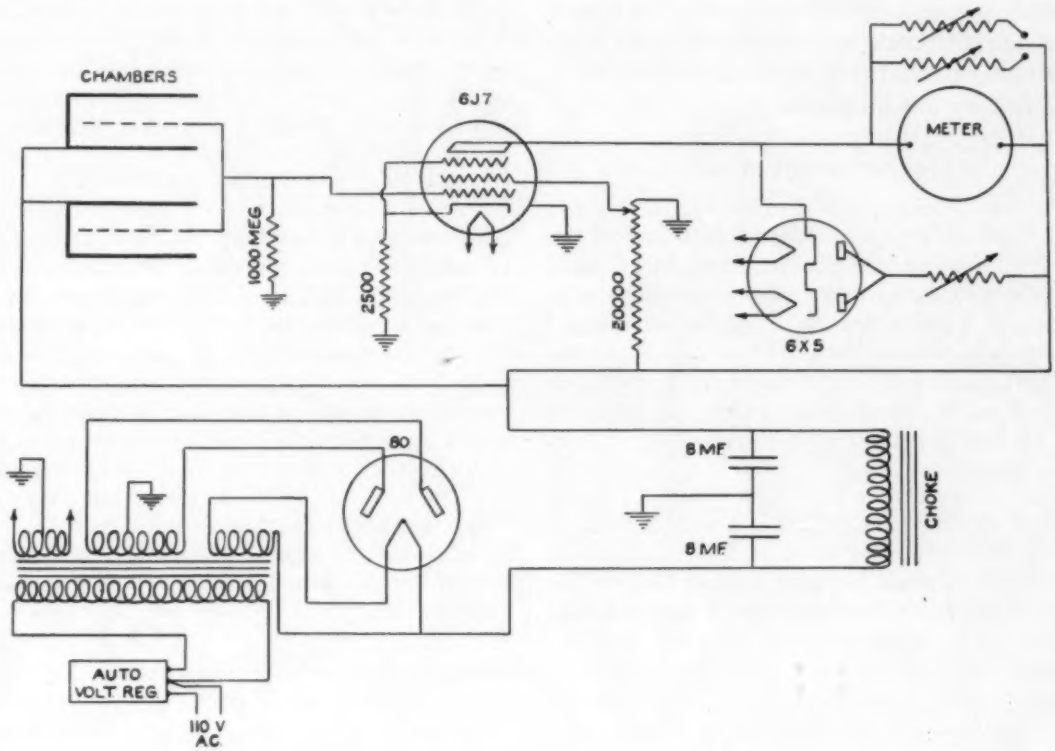

Fig. 2

[1] Taft, R. B. Electronic emission from vacuum tube as substitute for battery. *Rev. Scient. Instruments*, 1939, 9, 282.

tions could be practically eliminated but the sensitivity would be greatly reduced and the machine made very cumbersome. The sides of the chambers turned to the radium are covered with 1/16 inch lead which minimizes the difference to a great extent, but heavily filtered samples will give slightly lower readings than those of moderate filtration. However, as the filtration is always known, the instrument can be set up for the correct reading by the trimming resistors which enable the operator to set the reading exactly when a known sample of radium with similar filtration is placed in the machine.

DISCUSSION

DR. G. FAILLA, New York City. In listening to Dr. Taft's paper, I found that he left out only one thing in his instrument, and that is, how a color-blind person would be able to distinguish a green from a red scale. Seriously, I think it is inspiring to listen to Dr. Taft present papers from time to time on very ingenious schemes for doing things which the physicist is accustomed to do with elaborate apparatus. His instruments cost very little and modestly he says they can be built by anybody. Personally, I think that Dr. Taft is one of the exceptions and he is able to build these things and make them work. He gets a great deal of joy out of it. If all of us went out of our own field sometimes and "played" with other things, it would make life much more enjoyable.

DR. GEORGE E. PFAHLER, Philadelphia. In the early days we had Caldwell as our genius, and today we have Taft. I have never ceased to marvel at Dr. Taft's ingenuity and engineering ability, varying all the way from flying an airplane to measuring ions. It is quite a gamut, as you know, yet you see how successfully he has done it. This is just another of his numerous instruments that he has given to us for practical use.

I know I was not asked to discuss this subject because of my knowledge of the technical combinations that he has used here; I do not know anything about it. But I have always emphasized the importance of exactness or precision in our work, and secondly and more particularly, I have emphasized protection. I think that this instrument will help us to check on our protection by knowing exactly the quantity of radium that we are using. It enables us to check against loss, to check a specimen to see whether all of the radium is in that specimen that we have assumed to be present, or if we have held over a preparation or two or three similar preparations and they happen to get mixed up, we now do not have to tear them all apart in order to select the right one for our use.

These are little, practical things but they are very important to us in our daily work, and I, for one, want to express my thanks and appreciation for this new instrument that Dr. Taft has given us.

Vol. 42, No. 6

THE MIDWINTER CONFERENCE OF EASTERN RADIOLOGISTS

(HISTORICAL)

By JOSEPH F. ELWARD, M.D.
WASHINGTON, D.C.

THE Midwinter Conference of Eastern Radiologists is, in the main, a monument to the untiring efforts of Dr. David R. Bowen. He is, was and has been the meeting's guide, philosopher and friend.

There may be some discussion and difference of opinion as to who conceived the original idea, but the striking unanimity of thought regarding the fostering of it is a tribute to Dr. Bowen which is well merited and justly earned. Since practically all of his contemporaries give Dr. Bowen credit for the unbroken continuity of this meeting since prior to 1915, his account of the inception and origin of the meeting is accepted as the authentic version.

The Midwinter Conference of Eastern Radiologists was conceived in the fertile brain of Eugene W. Caldwell, and born when he invited a number of physicians limiting their practice to radiology to an informal meeting at the Hotel Dennis, New York City, in December, 1910. Enthusiasts at this meeting were Willis F. Manges and David R. Bowen. When the pressing problems of the new specialty had been discussed, Manges and Bowen made plans for a similar meeting during the winter of 1911–1912. Late in 1911 Bowen and Manges, who were now associated in practice at Philadelphia, with several other Quaker City practitioners invited radiologists of the East to a meeting in January, 1912, at the Chalfonte Hotel, Atlantic City, New Jersey. The program was quite informal, round table discussions being the order. A leader was selected when the group gathered. Then, as now, the problem of physician-hospital relationship was discussed at length, as were the diagnostic and therapeutic phases of practice. Anyone present was at liberty to speak freely, one of the problems of the meeting being the inability to curb those who had little, if anything to say, and took much too long to say it.

The following year, 1913, the annual periodicity of the meeting was established and the "Midwinter Meeting" became the accepted title. These informal meetings were held annually in January at Atlantic City during the years of 1912–1917 inclusive in the Hotel Chalfonte, and 1918–1919 in the Hotel Traymore.

The meeting grew in importance and it was thought by some that it should be under the official patronage and guidance of the American Roentgen Ray Society. Accordingly at the annual meeting of the American Roentgen Ray Society in 1919, at Saratoga Springs, New York, provisions were made for the establishment of sections in different parts of the country.

The Eastern Section included that part east of the States of Ohio, Kentucky, Tennessee and Mississippi. Eastern radiologists therefore comprised those in the following States: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, West Virginia, North Carolina, South Carolina, Florida, Alabama and the District of Columbia.

The first meeting of the Eastern Section of the American Roentgen Ray Society (Tenth Midwinter Meeting) was held in Atlantic City, Hotel Traymore, January 30–31, 1920. In tribute to the untiring interest and unflagging devotion to the Midwinter Meeting which the Eastern Section replaced, Dr. David R. Bowen, Philadelphia, was elected the first President; Dr. H. W. Van Allen had been appointed President pro tempore and presided, and Dr. Bowen, Secretary-Treasurer. The election

of Dr. Bowen was unanimous, indicating its general and unqualified approval by the group attending, which was said to be large. Dr. H. M. Imboden of New York City was elected Vice-President and Dr. J. M. Steiner, New York City, Secretary. The Constitution and By-Laws as provided for by the American Roentgen Ray Society at the Saratoga meeting were adopted. The roster of contributors to this first formal Midwinter Meeting may be of interest:

Howard E. Ashbury
Frederick H. Baetjer
Russel H. Boggs
David R. Bowen
James T. Case
Lewis Gregory Cole
W. D. Coolidge
Albertus Cotton
Byron C. Darling
Isaac Gerber
A. C. Heublein
George W. Holmes (by invitation)
H. M. Imboden
Chevalier Jackson (by invitation)
George C. Johnston
L. T. LeWald
Willis F. Manges
Charles L. Martin
H. K. Pancoast
George E. Pfahler
A. Howard Pirie
Dr. Quimby
Wm. H. Spencer (by invitation)
Wm. H. Stewart
Charles H. Viol
Charles A. Waters

The Second Annual Meeting of the Eastern Section of the American Roentgen Ray Society (Eleventh Midwinter) was held in Atlantic City at Chalfonte-Haddon Hall Auditorium, January 28–29, 1921, with the President, Dr. David R. Bowen, presiding. The attendance is not given but this meeting is said to have been the largest Midwinter Meeting ever held. Those in attendance expressed great enthusiasm. A commercial exhibit was inaugurated at this meeting.

The Third Annual Meeting (Twelfth Midwinter) was also held in Atlantic City in 1922, at the Ritz-Carlton Hotel. Information is not available concerning the details of this meeting, but the Officers were: J. M. Steiner, New York, President: C. A. Waters, Baltimore, Md., Secretary. The innovation was a three-day meeting.

The Fourth Annual Meeting (Thirteenth Midwinter) was held at the Ritz-Carlton Hotel, Atlantic City, January 25–27, 1923. The officers were: C. A. Waters, Baltimore, Md., President; Thomas A. Groover, Washington, D. C., Vice-President; Dr. Charles Eastmond, Brooklyn, N. Y., Secretary. The attendance was approximately three hundred and fifty. The highlight of the meeting was a paper by Dr. Walter E. Dandy, Baltimore, on "Localization of Brain Tumors by Cerebral Pneumography." Scientific and commercial exhibits were other features.

The Fifth Annual Meeting (Fourteenth Midwinter) of the Eastern Section was held in Atlantic City, Chalfonte-Haddon Hall, January 24–26, 1924. The officers were: Thomas A. Groover, Washington, D. C., President; Charles Eastmond, Brooklyn, N. Y., Vice-President; William C. Westcott, Atlantic City, Secretary.

The Sixth Annual Meeting (Fifteenth Midwinter) was held at Chalfonte-Haddon Hall, Atlantic City, January 22–24, 1925; Charles Eastmond, Brooklyn, N. Y., President; Ralph D. Leonard, Boston, Vice-President; Fred M. Hodges, Richmond, Va., Secretary.

This Midwinter Meeting was developing in scope and proportion, so that many thought the national organization meetings were losing prestige. For this reason it was deemed advisable to abandon the Sections of the American Roentgen Ray Society. The founders of the Midwinter Meeting (Bowen, Manges, *et al.*) felt that such a meeting filled a definite need, and with the abandonment of the Sections it was decided to return to the informal invitation meeting with no rules, no officers, which prevailed from 1911 (December, 1910) through 1919.

In 1925, at the last meeting of the Eastern Section, Ralph D. Leonard, Boston,

FIG. 1. Photograph taken at the Midwinter Meeting of Eastern Radiologists, Atlantic City, N.J., January 29–30, 1915.

1. Dr. Frederick Hutton
2. Unknown
3. Dr. Anthony Bassler
4. Dr. Charles Eastmond*
5. W. D. Coolidge, Ph.D.
6. Mr. Moore
7. Mr. W. S. Kendrick
8. Dr. Leopold Jaches*
9. Dr. Lewis Gregory Cole
10. Dr. Roland Hammond
11. Dr. Arthur S. Unger
12. Dr. Augur Hagopian
13. Dr. George Johnston
14. Dr. Henry K. Pancoast*
15. Mr. F. Saxby
16. Dr. F. W. O'Brien
17. Dr. Willis F. Manges*
18. Dr. George E. Pfahler
19. Dr. John T. Farrell, Sr.
20. Dr. A. H. Pirie
21. Dr. Francis F. Borzell
22. Dr. Samuel Stern
23. Dr. Arial W. George
24. Dr. David R. Bowen*
25. Dr. Wm. H. Schmidt
26. Dr. Byron C. Darling*
27. Dr. Arthur F. Holding
28. Dr. Harvey W. Van Allen*
29. Mr. Leo Katrachek
30. Dr. Leon T. LeWald
31. Dr. Walter C. Barker
32. Dr. Henry A. Cleaver
33. Dr. W. H. Merrill
34. Dr. Jacob Frank
35. Dr. Thomas A. Groover
36. Dr. I. Seth Hirsch
37. Dr. John H. Selby
38. Dr. Frank B. Granger*
39. Unknown
40. Dr. Russell H. Boggs*
41. Dr. Frederick M. Law
42. Dr. A. Judson Quimby
43. Dr. Max Kahn*
44. Mr. George W. Brady*
45. Dr. Wm. S. Newcomet
46. Dr. Gerald D. Bliss
47. Dr. Wm. Louis Chapman
48. Dr. George F. Thomas*
49. Unknown
50. Dr. Harry M. Stewart
51. Dr. Charles J. Search
52. Dr. Henry N. Thissell
53. Unknown
54. Dr. W. A. Quimby
55. Dr. Thomas Stewart
56. Dr. Percy Brown
57. Unknown
58. Dr. Edward C. Titus
59. Unknown
60. Dr. Wm. L. Clark*
61. Mr. Paul B. Hoeber*
62. Unknown
63. Mr. Fred Wiggin
64. Dr. George W. Holmes

* Deceased

was elected President; Howard E. Ashbury, Baltimore, Vice-President; Fred M. Hodges, Richmond, Va., Secretary. It was probably because of Dr. Leonard's election that the New England Roentgen Ray Society invited the roentgenologists of the East to meet informally at the Somerset House in Boston, January 25–26, 1926 (Sixteenth Midwinter). This meeting was well attended.

The New York Roentgen Ray Society issued invitations to a meeting in January, 1927, in New York City (Seventeenth Midwinter). The response to the invitation, and the interest of those attending warranted the appointment of a Continuance Committee composed of a member from each of the five major cities participating. These were:

David R. Bowen Philadelphia Chairman
Arthur C. Christie, Washington, D. C.
George W. Holmes, Boston, Mass.
Leopold Jaches, New York
Charles A. Waters, Baltimore

In 1928 (Eighteenth Midwinter), the Philadelphia Roentgen Society entertained the meeting at various hospitals in that City: Chairman, E. P. Pendergrass; Secretary, Walter C. Barker.

In 1929 (Nineteenth Midwinter) the roentgenologists of Washington entertained with a similar program: Chairman,

A. C. Christie; Secretary, J. F. Elward; as did Boston (Twentieth Midwinter) in 1930: Chairman, G. W. Holmes; Secretary, T. R. Healy; Baltimore in 1931 (Twenty-first Midwinter): Chairman, C. A. Waters; Secretary, H. J. Walton; New York (Twenty-second Midwinter) in 1932: Chairman, Leopold Jaches; Secretary, J. B. Edwards; Philadelphia (Twenty-third Midwinter) in 1933: Chairman, B. P. Widmann; Secretary, Karl Kornblum;

First Annual Meeting
of the
Eastern Section
of the
The American Roentgen Ray Society

Hotel Traymore

Atlantic City, New Jersey

Friday Evening and Saturday, January 30th and 31st
1920

OFFICERS
(Pro Tem.)
President, DR. HARVEY W. VAN ALLEN.
Secretary-Treasurer, DR. DAVID R. BOWEN.

FOREWORD

The Eastern Section of the American Roentgen Ray Society is one of the sections authorized at the Saratoga Meeting and comprises all that territory lying east of the eastern boundaries of Ohio, Kentucky, Tennessee, and Mississippi.

The annual meetings will replace the "Annual Eastern Midwinter Meetings" which have been so popular during the past five winters.

The general plan of this meeting will follow the lines of the "Midwinter" with the exception that the program will be limited to members of the Section and such others as have been invited to participate.

ALL PHYSICIANS are invited to attend, and this notice is being mailed to all who have heretofore evinced any interest in these meetings; at least such is the intention.

LANTERN SLIDE EXHIBITS

Especial attention will be paid at this meeting to the lantern demonstration and opportunity will be given, so far as possible, to any physician, whether member or not, to take part in this. Non-members are asked, however, to present their slides, together with an abstract of the talk, to the President or Secretary of the Section in order that they may be passed by the Exhibit Committee.

The following program is tentative at least as to the first evening. It is hoped that the slide entries will be so numerous as to make it necessary to show a part of them during the first evening

FIG. 2. Title page of program of First Annual Meeting of the Eastern Section of the American Roentgen Ray Society, 1920.

Washington (Twenty-fourth Midwinter) in 1934: Chairman, A. C. Christie; Secretary, F. O. Coe; Boston (Twenty-fifth Midwinter) in 1935: Chairman, G. W. Holmes; Secretary, Richard Dresser; Baltimore (Twenty-sixth Midwinter) in 1936: Chairman, C. A. Waters; Secretary, W. B. Firor; New York (Twenty-seventh Midwinter) in 1937: Chairman, Leopold Jaches; Secretary, R. W. Lewis; Philadelphia (Twenty-eighth Midwinter) in 1938: Chairman, H. T. Stull; Secretary, W. E. Chamberlin; Washington (Twenty-ninth Midwinter) in 1939: Chairman, E. M. McPeak; Secretary, J. F. Elward. In 1931, Dr. Bowen, as the result of illness, was forced into a period of inactivity. In 1937, Dr. Elwood E. Downs, the President of the Philadelphia Roentgen Society was appointed Alternate and served until his sudden death in March, 1939. Dr. Leopold Jaches also died in March, 1939, and Dr. H. W. Van Allen in 1938. From the schedule outlined it will be noted that the meetings in the various cities always fall in the same final numeral years. The entire meeting place history, past, present and future (to 1976) may be summed up in some such fashion as follows: New York, 1910—December. Atlantic City, 1912 -13 -14 -15 -16 -17 -18 -19 -20 -21 -22 -23- 24 -25; Boston, 1926 -30 -35 -40 -45 -50 -55 -60 -65 -70; New York, 1927 -32 -37 -42 -47 -52 -57 -62 -67 -72; Philadelphia, 1928 -33 -38 -43 -48 -53 -58 -63 -68 -73; Washington, 1929 -34 -39 -44 -49 -54 -59 -64 -69 -74; Baltimore, 1931 -36 -41 -46 -51 -56 -61 -66 -71 -76, or stated more simply:

Boston	0 and 5 year endings
Baltimore	1 and 6 year endings
New York	2 and 7 year endings
Philadelphia	3 and 8 year endings
Washington	4 and 9 year endings

The meetings since 1926 have been held at various hospitals in the key cities. This necessitated transportation to and from hotel and from hospital to hospital. It was thought by many that this was expensive and inconvenient as the material usually presented could be shown at a central meeting place. The Philadelphia meeting in 1938 was in keeping with the "central meeting place" idea, all sessions being held at the Hotel Warwick. A ballot was provided for expression of opinion. This expressed opinion was overwhelmingly in favor of all sessions being held at a central meeting place—the hotel headquarters.

The General Committee met informally in Atlantic City in September, 1938, during

the annual meeting of the American Roentgen Ray Society; present were Leopold Jaches, New York; Thomas A. Groover, representing Arthur C. Christie, Washington, D. C.; Elwood E. Downs, alternate for David R. Bowen, Philadelphia; Charles A. Waters, Baltimore, Md. George W. Holmes of Boston was absent. It was decided that the type of meeting be left to the discretion of the hosts. The decision is theirs whether the sessions be held at hospitals, at one central meeting place, as was done by the Philadelphia group in 1938, or in Atlantic City as was done originally. During the Philadelphia meeting a registration fee of $5.00 was suggested by Dr. Fred M. Hodges of Richmond. The Committee recommended that this practice be instituted commencing with the Washington meeting in 1939.

The Washington meeting in 1939, was held on Friday and Saturday, February 10 and 11, with E. M. McPeak, Chairman and J. F. Elward, Secretary. The registration fee was $5.00. All sessions were at the headquarters of the meeting, Hotel Mayflower. One hundred and eighty-five registered at the meeting. Nineteen states were represented. Dr. David R. Bowen in recognition of his long and faithful service to the Midwinter Conference and as a founder of the meeting was elected Permanent Honorary Chairman of the General Committee. Dr. Joseph F. Elward, was elected Recording Secretary of the General Committee.

As a matter of interest there is included herewith a photograph of the group meeting in Atlantic City, in 1915 (Fig. 1). There is also included a reproduction of the title page of the program of the first meeting of the Eastern Section of the American Roentgen Ray Society, January 30–31, 1920 (Fig. 2).

Finally, may I pay tribute to those who have passed on by calling the roll: Bundy Allen, Frederick H. Baetjer, Webster W. Belden, Russell H. Boggs, David R. Bowen, Eugene W. Caldwell, William L. Clark, Bryon C. Darling, Walter J. Dodd, Elwood E. Downs, Charles Eastmond, Frank B. Granger, Alfred L. Gray, Arthur C. Heublein, Leopold Jaches, Byron J. Jackson, William A. LaField, Willis F. Manges, Joseph T. McKinney, L. B. Morrison, H. K. Pancoast, Charles A. Pfender, Clyde C. Phillips, James J. Quiney, Hunter B. Spencer, Joseph M. Steiner, Samuel Stern, H. W. Van Allen.

The author wishes to acknowledge with deepest thanks the kind cooperation of the following members and friends of the Midwinter Conference. This account, sketchy though it is, could not have been written without their help: H. E. Ashbury, P. A. Bishop, C. W. Blackett, D. R. Bowen, Percy Brown, P. F. Butler, N. G. Butler, A. C. Christie, L. G. Cole, R. D. Duckworth, John T. Farrell, Jr., Thos. A. Groover, Fred M. Hodges, A. F. Holding, G. W. Holmes, H. M. Imboden, L. T. LeWald, G. M. MacKee, W. S. Newcomet, F. W. O'Brien, C. B. Peirce, G. E. Pfahler, John Remer, J. H. Selby, M. C. Sosman, Ramsey Spillman, C. A. Waters, and W. C. Westcott.

THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Forty-first Annual Meeting: Boston, Mass., October 1-4, 1940.

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Delegates to the Sixth International Congress of Radiology: Albert Soiland, Los Angeles, Calif., Delegate, Zoe A. Johnston, Pittsburgh, Pa., Alternate Delegate.

Twenty-fifth Annual Meeting: New York City, June 10-11, 1940.

EDITORIALS

THE RADIOTHERAPEUTIC ASPECT OF MALIGNANT TUMORS OF THE THYROID GLAND

IN THE composite group of cancerous growths of all locations, malignant tumors of the thyroid gland occupy a somewhat unusual position. On the one hand, they are quite rare, with an incidence of 1 per cent or less. On the other hand, their structure is so diversified that a precise histopathologic classification or even a differentiation from more benign tumors often appears difficult. It is not surprising, therefore, that the medical literature is very meager in publications dealing with the treatment aspect of these lesions in general and their radiotherapeutic aspect in particular.

Portmann,[1] on the basis of a study of the rich clinical material of the Cleveland Clinic Foundation, was able to report recently on 200 consecutive cases of malignant tumors of the thyroid treated between 1922 and 1933, mostly by surgery or radiation therapy or by a combination of the two. The compilation of such a large group of cases from one single institution, together with the keen sense of medical analysis and thoroughly expert knowledge of radiotherapeutic applicability which characterizes the author, makes possible the establishment of certain rules which may be accepted as more or less fundamental.

Histopathologic Classification. Graham[2] in 1925 classified the malignant tumors of the thyroid from the histopathologic standpoint as follows:

I. Carcinomas originating in pre-existing adenomas
   1. Malignant adenomas
   2. Papillary carcinomas
II. Carcinomas without evidence of having originated in pre-existing adenomas
   1. Adenocarcinomas
   2. Scirrhous carcinomas
III. Mixed type
   1. Carcinoma-sarcoma
IV. Sarcomas
   1. Lymphosarcoma
   2. Fibrosarcoma
   3. Other types

As one might expect, the majority of the malignant tumors of the thyroid occur as a result of a degenerative process in pre-existing goiters, mostly adenomas of long duration. In Portmann's series, not less than 71 per cent of the tumors were proved to have originated in pre-existing adenomas, 55 per cent being of the malignant adenoma and 16 per cent of the papillary carcinoma type. This incidence has great significance from the clinical standpoint. It indicates, among other things, that whenever a simpler goiter starts to increase its rate of growth, potential malignant degeneration becomes a primary consideration, although in many instances the presence of malignant cells is detected accidentally at operation, when thyroidectomy is performed for an apparently harmless benign struma. According to Graham, the fully developed malignant changes may assume the morphologic characteristics of any type of cancerous neoplasm, such as scirrhous, medullary, papillary or adenocarcinoma, or even carcinosarcoma. But what will distinguish chiefly these malignant adenomas from other malignant tumors of the thyroid is the fact that the blood vessels are widely invaded whereas in the other types the ex-

[1] Portmann, U. V. Malignant tumors of the thyroid gland; report of 200 consecutive cases. *Transactions of the Third International Goiter Conference.*

[2] Graham, A. Malignant tumors of thyroid; epithelial types. *Ann. Surg.*, 1925, *82*, 30–44.

tension occurs through the lymphatics. The papillary carcinomas are identified by their typical papillary morphology.

The malignant tumors of the thyroid without evidence of having originated in pre-existing adenomas represent in Portmann's series 29 per cent. Most frequent among them is the adenocarcinoma with 14 per cent and the lymphosarcoma with 8 per cent, whereas the remaining types are rather uncommon. The histopathologic appearance of all these tumors is the same as that of similar neoplasms encountered in other locations of the body.

Classification According to the Extent of the Disease. However elaborate a histopathologic classification may be, it is observed in practice that often a far greater prognostic evaluation is secured in all types of malignant neoplasms by ascertaining the clinical extent of the disease. This is especially true when one wishes to make a comparative study of the value of the different methods used for treatment, as, for example, surgery, radiation therapy, etc. With this view in mind, Portmann proposes the following plan of clinical grouping for the malignant tumors of the thyroid gland:

Group I. Cases without clinical evidence of malignant tumor which was discovered only after microscopic examination, the tumor being only a few millimeters in diameter.

Group II. Cases without clinical evidences of malignant tumor or in which its presence was suspected only on the basis of a history of rapid enlargement of the thyroid gland; or discovered at operation and the growth was still localized within the thyroid capsule.

Group III. Cases with clinical evidences of malignant tumor which had invaded or extended outside of the thyroid capsule to neighboring or distant structures.

Perhaps one may detach from Group III the cases with extension to distant structures and place them in a separate Group IV. Such a course may appear justified on the basis of the fact that distant metastases in most malignant tumors of the thyroid represent dissemination by the blood stream, signifying thus a very bad prognosis. In the cases with extracapsular invasion of neighboring structures, the extension is by continuity or through the lymphatics and thus the outlook a little more favorable. Indeed, in some instances of the latter group, the malignant neoplasm may be completely eradicated by radiation therapy and in others the progress of the disease may be slowed down to such an extent that life is prolonged for many years, the longest survival on record being eighteen years.

In Portmann's series, 15.2 per cent of the cases fell in Group I, 16.3 per cent in Group II and 68.5 per cent in Group III. These figures bear similarity to other meager data found in the literature, so that one may affirm that more than two-thirds of the patients afflicted with malignant tumors of the thyroid arrive under medical observation at a stage when successful surgical intervention is already impracticable and radiation therapy alone may be applied.

Radiotherapeutic Procedure. Malignant tumors of the thyroid, whether treated by radiation therapy alone, or by a combination of surgery and radiation therapy, are best irradiated in all clinical stages with roentgen rays. A few authors have made use of radium packs and occasionally of telecurietherapy, but the data available are not sufficient to warrant definite conclusions.

The roentgen therapy in the earlier years was carried out with the so-called massive method. A full erythema dose, or at the least large fractions thereof, were administered per seance and per field, four to six fields being used for the purpose of cross-firing. The series, as a rule, was concluded within four to twelve days and repeated, if thought necessary, at intervals of six to eight weeks for two or three additional series.

During the past ten years, this procedure has gradually given way to the protracted, fractionated method which is now being used almost exclusively. A daily dose of 200 to 300 r is given alternately over each side of the neck or such other fields as may ap-

pear advisable. The series is extended over a period of three to four weeks, or even longer, until by taking into account the radiation loss, a cumulated dose of 170 to 180 per cent erythema dose is reached on the surface of the skin. The irradiation may be repeated with gradually decreasing cumulated doses at intervals of eight to twelve weeks, depending on the condition of the skin and the status of the malignant process.

The quality of the roentgen rays employed in all instances was that obtained with 200 kv. (1–2 mm. Cu). More recently, harder rays, obtained with 500–1,000 kv. (7 mm. Cu) were also tried, but the improvement in the late results appears questionable, although they are being produced with less damage to the skin.

Results and Indications. The cases falling in clinical Group I are usually diagnosed by the pathologist, in most instances no sign of a malignant process being detected even at the operation which, as a rule, is performed for some benign adenoma of the thyroid. Since the disease focus has been completely removed, a good final result may be expected and the use of postoperative radiation therapy appears rarely indicated.

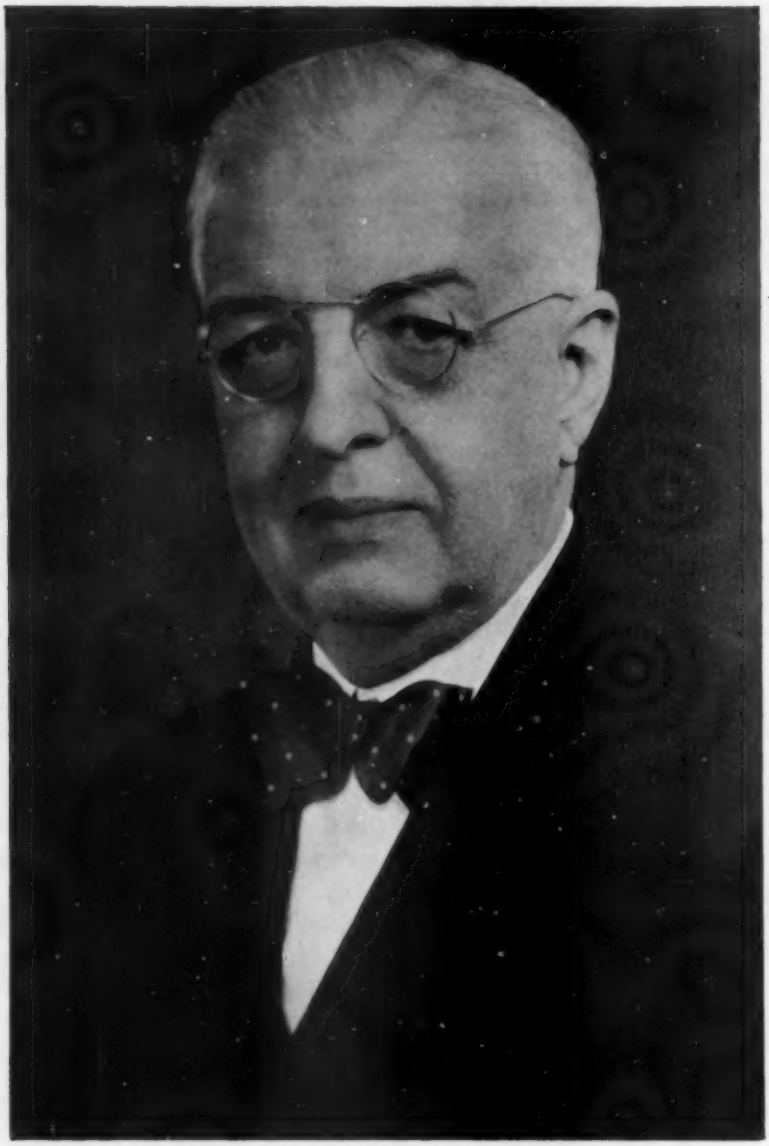
In Group II, Portmann's series shows a five year survival of approximately 50 per cent by operation alone. It seems, however, that postoperative irradiation is indicated routinely since several of the recurrent surgical cases which subsequently were treated by radiation therapy responded favorably.

In Group III, radiation therapy is the only method applicable. Good palliation with prolongation of life is obtained quite frequently and in a certain number of cases a survival of five years or longer is observed.

If a fourth group is added for the cases with distant metastases, the prognosis here appears exceedingly bad. Only a few cases will survive one year, despite therapeutic attempts of any sort.

All in all, one may unhesitatingly state that the radiotherapeutic aspect of malignant tumors of the thryoid gland acquires an ever increasing clinical importance. Already 85 per cent of the cases are being predominantly treated by radiation therapy and if one wishes to follow an entirely safe course, the procedure may be extended to all malignant tumors, early or late. In one-third, radiation therapy supplements surgery; in the other two-thirds, it practically supplants it. The results are impressive and with the newer technical advances they may be expected to be further improved in the future.

T. Leucutia



DAVID RALPH BOWEN
1872-1939

"TO LIVE so that my posterity, my students and my associates may be the better for my having lived; that fathers, mothers and children may have been helped; and that none shall stumble because of ideas to which I have given voice or pen: this is my creed, my moral and social code."

Thus did Dr. Bowen, in his creed, express the philosophy that those of us fortunate enough to have worked with him observed in his daily contact with his patients, his fellow physicians and his friends.

David Ralph Bowen was born on Southwick Farm near Owego, New York, June 3, 1872. His father was of Welsh stock; his

mother the twelfth generation descended from John Alden and Priscilla Mullins. During an uneventful childhood on the farm his activities were somewhat limited by poor health. When fourteen years of age he entered Wyoming Seminary, a Methodist school near Wilkes-Barre, Pennsylvania. The school had a strong religious character, of which he said, "I owe much to its formation of my character."

Graduating in 1890, he was able to realize an early ambition to study medicine by entering Jefferson Medical College in the fall of the following year (1891). He received his degree just after his twenty-second birthday but, because of his youthful appearance, he was unable to obtain an internship, and after passing the New York State Board examination he entered directly into country practice in Orleans County. Although successful in each community he moved frequently during the next several years. Of this period he wrote, "As I look back on my country practice I seem to have been beset by two errors, one a strong wanderlust. Any feeling of failure or insufficiency seems to have been promptly suggestive of a change of location. This was the more unfortunate because, though it was not recognized by that name, I had a marked inferiority complex."

In 1906 he had his first personal contact with roentgenology. Associated with Drs. Reid and Stranahan in their clinic in Rome, New York, he found a discarded Wappler coil with a Caldwell interrupter which had, in the clinic's hands, been a dismal failure. By arduous reading and experimentation, his first subject being a large wharf rat, his diagnostic results were soon such that they were enthusiastically received by his associates.

In 1907 he spent two weeks with Dr. Sidney Lange in Cincinnati. During this fortnight he attended the meeting of the American Roentgen Ray Society, where he heard discussions of protection against roentgen-ray burns and received an "exaggerated impression of the importance of extreme precautions" which remained with him throughout his active days. No student or assistant came in contact with him without being impressed by his feelings. To the day of his death his hands were free from any changes caused by radiation.

In March, 1911, he came to Philadelphia to begin his association with a man who became his ideal, "the most perfect character I have ever known," Dr. Willis F. Manges. During these years the "inventive tendency" which he inherited from his father blossomed. The American Journal of Roentgenology was showered by his concise papers on "Devices" and technique so that in 1924, when the Department of Technique was established, he quite naturally became its first editor.

In 1920 Dr. Bowen left Jefferson Hospital to head the Department of Roentgenology at the Pennsylvania Hospital. Here he displayed his rare ability by developing a splendid and efficient organization. His procedures were based on exacting technique and honest efforts of interpretation, flavored with a sympathetic management of patients and their families. He was an ardent champion of every patient whom he even suspected was not getting a "square deal" in the midst of "hospital routine," which he deplored. He had lost his "inferiority complex." He considered himself a clinician in roentgenology and a consultant and he loved to give battle when his rights were challenged. With his students he was patient, yet exacting, always stimulating and inspiring. Manges wrote to him after the onset of his illness, "It is gratifying, to me at least, that the first impressions I had of you, even before I knew you well, have remained the most striking and characterizing throughout our many years of relations. I am sure that the ethical status of roentgenology in Philadelphia is better than in most large cities, and that much of it is due to your personal character and influence."

Dr. Bowen was an enthusiastic member of the American Roentgen Ray Society and attended every meeting from 1907, when he was admitted to membership, until he

was incapacitated after the 1937 meeting. He was prominent in the activities of the Philadelphia Roentgen Ray Society and those of the "Eastern Section." After the latter was discontinued he was largely responsible for the establishment of the annual Conference of Eastern Radiologists.

In 1895 Dr. Bowen was married to Mary A. Moe who bore him five children. She died in 1918. Late in 1919 he married Edith Warrington, whose devoted care made his eight years of disability pleasant and enjoyable among his hobbies until he passed away peacefully during the early morning of September 6, 1939.

Paul A. Bishop

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

United States of America

American Roentgen Ray Society
Secretary, Dr. C. B Peirce, Royal Victoria Hospital, Montreal, Canada. Annual Meeting: Boston, Mass., Oct. 1-4, 1940.

American College of Radiology
Secretary, Mac F. Cahal, 540 N. Michigan Ave., Chicago, Ill. Next Annual Meeting: New York City, June 12, 1940.

Section on Radiology, American Medical Association
Secretary, Dr. J. T. Murphy, 421 Michigan St., Toledo, Ohio. Annual meeting: New York City, June 10–14, 1940.

Radiological Society of North America
Secretary, Dr. D. S. Childs, 607 Medical Arts Bldg., Syracuse, N. Y. Annual meeting: Atlanta-Biltmore Hotel, Atlanta, Ga., Dec. 11–15, 1939.

Radiological Section, Baltimore City Medical Society
Secretary, Dr. Walter L. Kilby, Baltimore. Meets third Tuesday each month, September to May.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Max Climan, 242 Trumbull St., Hartford, Conn. Meets twice annually in May and September.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. H. W. Ackemann, 321 W. State St., Rockford, Ill. Next meeting Peoria, Ill., May 21–23, 1940.

Radiological Section, Los Angeles Co. Med. Soc.
Secretary, Dr. Wilbur Bailey, 2007 Wilshire Blvd., Los Angeles, Calif. Meets on second Wednesday of each month at County Society Building.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Brooklyn Roentgen Ray Society
Secretary, Dr. L. J. Taormina, 1093 Gates Ave., Brooklyn, N. Y. Meets monthly on first Tuesday, October to April.

Buffalo Radiological Society
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St., Buffalo, N. Y. Meets second Monday of each month except during summer months, place of meeting selected by the host.

Chicago Roentgen Society
Secretary, Dr. C. J. Challenger, 3117 Logan Blvd. Meets second Thursday of each month October to May inclusive at the Hotel Sherman.

Cincinnati Radiological Society
Secretary, Dr. J. E. McCarthy, 707 Race St., Cincinnati, Ohio. Meets third Tuesday of each month, October to May, inclusive.

Cleveland Radiological Society
Secretary, Dr. H. A. Mahrer, 10515 Carnegie Ave. Meets at 6:30 P.M. at Mid-Day Club rooms on fourth Monday each month, October to April, inclusive.

Denver Radiological Club
Secretary, Dr. E. A. Schmidt, 4200 E. 9th Ave., Denver, Colo. Meets third Tuesday of each month.

Detroit Roentgen Ray and Radium Society
Secretary, Dr. E. R. Witwer, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

Florida State Radiological Society
Secretary, Dr. J. N. Moore, 210 Professional Bldg., Ocala, Florida. Meetings in May and November.

Georgia Radiological Society
Secretary, Dr. R. C. Pendergrass, Prather Clinic Bldg., Americus, Ga. Meets in November and at annual meeting of Medical Association of Georgia in the spring.

Illinois Radiological Society
Secretary, Dr. E. P. Halley, Decatur and Macon County Hospital, Decatur, Ill. Meetings held quarterly, time and place designated by president.

Indiana Roentgen Society
Secretary, Dr. C. C. Taylor, 23 E. Ohio St., Indianapolis, Ind. Meeting held the second Sunday in May annually.

Kentucky Radiological Society
Secretary, Dr. J. C. Bell, 402 Heyburn Bldg., Louisville. Meets annually in Louisville on third Sunday afternoon in April.

Long Island Radiological Society
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:30 P.M.

Michigan Association of Roentgenologists
Secretary, Dr. C. S. Davenport, St. Lawrence Hospital, Lansing. Three meetings a year, Fall, Winter, Spring.

Milwaukee Roentgen Ray Society
Secretary, Dr. I. I. Cowan, Mt. Sinai Hospital, Milwaukee, Wis. Meets monthly on first Friday at University Club.

Minnesota Radiological Society
Secretary, Dr. J. P. Medelman, 572 Lowry Medical Arts Bldg., St. Paul.

Nebraska Radiological Society
Secretary, Dr. D. A. Dowell, Medical Arts Bldg., Omaha, Nebr. Meets first Wednesday of each month, at 6 P.M., at either Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. A. O. Hampton, Massachusetts General Hospital, Boston, Mass. Meets monthly on third Friday, Boston Medical Library.

Radiological Society of New Jersey
Secretary, Dr. W. J. Marquis, 198 Clinton Ave, Newark. Meets annually at time and place of State Medical Society. Mid-year meetings at place designated by president.

New York Roentgen Society
Secretary, Dr. R. D. Duckworth, 170 Maple Ave., White Plains, N. Y. Meets monthly on third Monday, New York Academy of Medicine, at 8:00 P.M.

North Carolina Roentgen Ray Society
Secretary, Dr. Major Fleming, Rocky Mount, N. C. Annual meeting at time and place of State Medical Society. Mid-year scientific meeting at place designated.

Central New York Roentgen Ray Society
Secretary, Dr. C. F. Potter, 820 S. Crouse Ave., Syracuse. Three meetings a year—January, May, November.

Pacific Roentgen Club
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. L. E. Wurster, 416 Pine St., Williamsport, Pa. Annual meeting, June, 1940, exact time and place to be decided.

Philadelphia Roentgen Ray Society
Secretary, Dr. B. R. Young, Temple University Hospital. Meeting first Thursday of each month from October to May inclusive, at 8:15 P.M., in Thompson Hall, College of Physicians, 19 S. 22d St.

Pittsburgh Roentgen Society
Secretary, Dr. H. W. Jacox, 4800 Friendship Ave., Meetings held second Wednesday each month, 4:30 P.M., October to June at various hospitals.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. S. C. Davidson, 277 Alexander St., Meets on second Thursday from October to May, inclusive, 8 P.M., Rochester Academy of Medicine Building.

St. Louis Society of Radiologists
Secretary, Dr. W. K. Mueller, University Club Bldg. Meets fourth Wednesday of October, January, March and May, at a place designated by the president.

San Francisco Radiological Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco. Meets monthly on first Monday at 7:45 P.M., alternately at Toland Hall and Lane Hall.

* Secretaries of Societies not here listed are requested to send the necessary information to the Editor.

SOUTH CAROLINA X-RAY SOCIETY
Secretary, Dr. Hillyer Rudisill, Jr., Roper Hospital, Charleston. Meets in Charleston on first Thursday in November, also at the time and place of South Carolina State Medical Association.

TENNESSEE RADIOLOGICAL SOCIETY
Secretary, Dr. F. B. Bogart, 311 Medical Arts Bldg. Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

TEXAS RADIOLOGICAL SOCIETY
Secretary, Dr. H. C. Harrell, 517 Pine St., Texarkana, Texas.

UNIVERSITY OF MICHIGAN DEPARTMENT OF ROENTGENOLOGY STAFF MEETING
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

UNIVERSITY OF WISCONSIN RADIOLOGICAL CONFERENCE
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets every Thursday from 4:00–5:00 P.M., Room 301, Service Memorial Institute.

VIRGINIA RADIOLOGICAL SOCIETY
Secretary, Dr. V. W. Archer, University Hospital, University, Va. Meets annually in October.

WASHINGTON STATE RADIOLOGICAL SOCIETY
Secretary, Dr. K. J. Holtz, American Bank Bldg., Seattle. Meets fourth Monday of each month at the College Club, Seattle.

CUBA

SOCIEDAD CUBANA DE RADIOLOGIA Y FISIOTERAPIA
Secretary, Dr. Francisco Padron, Enrique, Villuendas 64, Havana, Cuba. Meets monthly in Havana.

BRITISH EMPIRE

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY
Meets monthly on third Thursday, from November to June inclusive, at 8:15 P.M., 32 Welbeck St., London.

SECTION OF RADIOLOGY OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8:15 P.M. at the Royal Society of Medicine, 1, Wimpole St., London, W. 1.

FACULTY OF RADIOLOGISTS
Secretary, Dr. Barbara M. Key, 32 Welbeck St., London, W.1, England.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Keith Hallam, St. George's Hospital, K.E.W., Melbourne, E. 4, Victoria, Australia. Meets monthly from March to Nov. incl. for scientific discussion.

CANADIAN ASSOCIATION OF RADIOLOGISTS
Secretary, Dr. A. C. Singleton, Medical Arts Bldg., Toronto, 5, Ontario.

SECTION OF RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. C. M. Jones, Inglis St., Ext., Halifax, N.S.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Anderson, Invercargill, New Zealand. Meets annually.

CONTINENTAL EUROPE

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

SOCIEDAD ESPANOLA DE RADIOLOGIA Y ELECTROLOGIA
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7, Madrid, Spain. Meets monthly in Madrid.

SOCIÉTÉ DE RADIOLOGIE MÉDICALE DE FRANCE
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel. Meets annually in different cities.

SOCIÉTÉ FRANCAISE D'ELECTROTHÉRAPIE ET DE RADIOLOGIE MÉDICALE
Meets monthly on fourth Tuesday, except during month of August and September, 12 Rue de Seine, Paris.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prague, II.52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GESELLSCHAFT FÜR RÖNTGENKUNDE UND STRAHLENFORSCHUNG)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent Secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

SÜD- UND WESTDEUTSCHE RÖNTGENSELLSCHAFT
Meets annually in different cities.

NORD- UND OSTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the Spring, and one in the fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, M. Ponzio, University of Turin, Prof. Turin

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Oscar Meller, Str. Banul Mărăcine, 30, S. I., Bucuresti, Roumania.
Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly on first Monday at 8 o'clock.

POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. Jan Kochanowski, 45 Gornoslazka St., Warsaw. Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with exception of the Denmark Society, meets every second month except in the summertime:

SOCIETY OF MEDICAL RADIOLOGY IN SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Secretary, Dr. G. Biering, Copenhagen.
Meets the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA ROENTGEN SOCIETY
Meets first Wednesday of each month, at 6:30 P.M. at Zentral-Röntgen Institut des allgemeinen Krankenhauses Alserstrasse 4.

ORIENT

JAPAN X-RAY ASSOCIATION
c/o Orthopedic Surgery, Tokyo Imperial University. Meets annually in April.

KINKI ROENTGEN-ABEND SOCIETY
Director, Dr. Prof. Taiga Saito, Ogawaoike Tyoto Japan. Meets bi-monthly on third Sunday.

BULLETIN OF THE INTER-SOCIETY COMMITTEE FOR RADIOLOGY

POINTS OF INTEREST

Those who missed the following excerpt from the *Berlin* letter appearing in the October 21 issue of the *Journal of the American Medical Association* should find it of interest:

Professor Lehman, of Rostock, treated the problem of the relations of surgical clinics and X-ray institutes. Roentgenology is not a separate specialty but a medical ally. The type of men who are merely roentgenologists will disappear. X-ray institutes conducted independently easily lose contact with the clinics and yet the work done in the X-ray laboratory is part and parcel of the work done in the clinics. The directors of X-ray divisions should be members of the clinical staffs. He admitted the great difficulties of an organizational nature. For special examinations such as those of pyelography, ventriculography and myelography, the ward system of hospitals with central X-ray institutes was not practical. Roentgenologists should not by themselves determine indications. Lehmann thinks that the X-ray department of a hospital should be in charge of a roentgenologist who is subject to the director of the surgical division. This position was challenged by the chairman of the society of German roentgenologists, who stated that the greatest importance was attached to close cooperation but that the problems discussed by Lehmann were still too unclarified to permit the roentgenologists to make a final decision.

* * *

For the past several years, certificates of specialty have been issued by the New York County Medical Society through its "Special Committee on Radiology" to New York radiologists meeting the committee's requirements. By action taken at a recent meeting, the Society will, after this year, issue certificates only to roentgenologists and radiologists who have been certified by the American Board of Radiology.

* * *

The Committee on Ethics of the *Nassau County Medical Society*, New York, recently mailed a bulletin to all members, calling their attention to certain items in the code of ethics, and decrying the patronage of commercial roentgenological and pathological laboratories by some members. The bulletin also called attention to the fact that the group hospitalization plan was being abused by "admissions for diagnostic purposes only."

* * *

Announcement was made by the Blue Cross Hospitalization Plan of *Boston* on September 12, that radiology would be removed from the benefits offered under the Plan. The announcement came after less than a year of experiment with radiology included as a hospital benefit. Previously the Plan had confined its benefits to hospital services alone. Administrators of the Plan returned to the former status because "there have been abuses of the service and misuse of X-ray benefits."

* * *

The following is from the *New York Medical Week*, published by the Medical Society of the *County of New York:*

Hereafter MEDICAL WEEK will not publish advertisements of any commercial laboratories. This is done in the interest of practicing pathologists, bacteriologists, radiologists and others who make of laboratory work a professional career as a specialty in medicine.

Laboratories, even those run by medical men, which are purely commercial in nature or connected directly or indirectly with commercial enterprises, will hereafter not be featured in our advertising columns.

* * *

The New Jersey Medical Society has joined the societies of California, Wisconsin, District of Columbia, and Michigan in the launching of a medically controlled sickness insurance plan. Payment to physicians and surgeons rendering service to subscribers in California and Michigan will be on a unit basis. In New Jersey, where subscriptions will cost approximately four cents a day, physicians will be paid on a re-

duced fee schedule. The Medical Society of Pennsylvania is preparing a plan the details of which have not been finally decided upon.

* * *

The extension of the functions of the hospital into the practice of medicine is presaged by a recent announcement by the Western Pennsylvania Hospital of *Pittsburgh*. To patients wishing to take advantage of it, the hospital offers a flat rate per diem plan which includes not only hospital accommodations but services of a pathologist, a radiologist, anesthetist, and metabolism and electrocardiographic examinations. One day's hospitalization in a semi-private room will cost $25.00.

* * *

The following resolution was adopted at the recent annual meeting of the *Medical Association of Georgia:*

WHEREAS: It is the studied opinion of most physicians that it is in the public interest that the practice of medicine be carried on by individual physicians and not by institutions, and

WHEREAS: It has been brought to the attention of the Medical Association of Georgia in resolutions presented by the Georgia Radiological Society, that certain institutions in Georgia are practicing medicine in that they are providing radiologic services to patients, both hospitalized and non-hospitalized, for a pecuniary consideration and to the financial detriment of private practitioners, and

WHEREAS: Such practice has been condemned by the American Medical Association whose code of ethics provides that it shall be unethical for a physician to dispose of his services to a corporation or other organization in such a manner that such organization shall realize a profit from his professional activities, and

WHEREAS: The Medical Association of Georgia has been memorialized by the Georgia Radiological Society to take remedial measures in this matter, therefore,

BE IT RESOLVED by the House of Delegates of the Medical Association of Georgia, that we endorse the position of the American Medical Association on the above question, and

That we authorize the Committee on Medical Defense of the Medical Association of Georgia, on complaint of any member of the Medical Association of Georgia residing in an area where practices above described are said to exist, and where such practices are detrimental to the financial interest of private physicians, to investigate such complaint and to use the instrumentalities of the Medical Association of Georgia to correct any unfair practice which may be found to exist.

* * *

One of the most interesting exhibits at the Hall of Science in San Francisco's Golden Gate Exposition was one entitled "Magic Shadows" which was prepared by the *Pacific Roentgen Club*. The difference between photography and roentgenography was demonstrated in the exhibit and illustrations were provided of the uses of the roentgen ray in the study of anatomy, in obstetrics, pediatrics, oncology, and the industrial diseases.

* * *

The Section on Radiology of the *Visconsin State Medical Society* has been conducting a vigorous campaign to protect the specialty of radiology in connection with a proposed hospital insurance plan now in the process of formation. An act enabling the formation of group hospitalization plans, sponsored by the State Medical Society, passed the Wisconsin legislature at its last session and was signed by the Governor. The law provides that such plans "shall provide for hospital services only and shall not embrace medical services."

Despite this clear provision in the law, efforts are being made in certain directions to include radiology as a part of hospital care among the benefits offered by the plan. While disapproving of their inclusion as a violation of the law, the Council of the Wisconsin State Medical Society has agreed that radiology and pathology may be included as benefits if provided "on a cash basis over and above the per diem return to the hospital." The Section on Radiology has not withdrawn its demands for the complete exclusion of radiology.

MAC F. CAHAL
Executive Secretary

NOBEL PRIZE IN PHYSICS

"The Nobel Prize in physics for 1939 has been awarded by the Swedish Academy of Science to Dr. Ernest O. Lawrence, professor of physics and director of the radiation laboratory of the University of California, in recognition of his research into the structure of atoms and the use of radiation in problems affecting biology and medicine."

This announcement, quoted from the November 17 issue of *Science*, is one which will have the approval of all radiologists. The following interesting amplification of the bare announcement is taken from the editorial columns of the *New York Times*, November 11, 1939, and is entitled "Our Latest Nobel Laureate":

The award of the Nobel Prize to Professor Ernest O. Lawrence of the University of California serves to remind us not only of the eminence of the United States in scientific investigation but of the demands made upon the ingenuity and technical resourcefulness of prize recipients. Professor Lawrence's contribution to physical science is his cyclotron, an electrical sling-shot which whirls projectiles around and around until at last they acquire so much energy that, when hurled against a bit of matter, they deliver shattering blows. When we think of Professor Lawrnece and his work we are more apt to think of the results that he has achieved with this machine-gun than of the machine itself—think, for example, of making cheap common salt radioactive with the hope that some day it will take the place of costly radium in the treatment of cancer. This is as it should be. To Professor Lawrence the cyclotron is but a means to an end—the great end of revealing the structure of the atom.

The pioneers in experimental physics have always had to devise their own instruments of investigation. Men like Faraday, Hertz and Helmholtz are not listed among the great inventors. For the servants of science invent as a matter of course, rarely take out patents, and concentrate on research. Who thinks of Hertz's simple detector of electric waves as the first wireless apparatus, or of the apparatus with which Faraday discovered electromagnetic induction as the germ of the electric generator and motor? If Professor Lawrence were what is called a "practical" inventor and his cyclotron were of any immediate commercial use he would take his place beside Watt, Arkwright, Bell, Edison and Marconi, which would probably exasperate rather than flatter him.

Another aspect of the award to Professor Lawrence that is apt to escape us is the debt that research owes to American philanthropy. The new 200-million-volt machine with which Professor Lawrence will deliver still mightier blows to resistant atomic nuclei will cost at least $750,000,which will come from some fund. It does not belittle him to say that his triumphs were made possible by generous financial support. If he had not decided to batter atoms on an expensive scale, he would have made his mark in some branch of science other than atomic physics. Apparatus alone does not make a true scientist of an experimenter. Yet the Nobel Prizes that have been awarded to American physicists drive home the fact that we are fortunate in having philanthropists who realize keenly the high importance of the work that men like Professor Lawrence are doing.

DIRECTORY OF MEDICAL SPECIALISTS

The Advisory Board for Medical Specialties will issue in December the first edition of the *Directory of Medical Specialists* listing approximately 14,000 specialists certified by the twelve American Boards and the two affiliate Boards in the Specialties.

This Directory will have three sections. The first will be devoted to a brief discussion of the Advisory Board for Medical Specialties, its organization and objectives. The second section will have fourteen separate divisions, one for each American Board with a geographic and a detailed biographic listing of its Diplomates. Each of these divisions will give full information regarding requirements for admission to examinations for certification, details of organization of each Board, and other general information. The third and final section will be a complete alphabetic list of all 14,000, Diplomates, with their addresses and indications of specialty certification.

It is expected to issue the Directory every two years. No charge is made for any listing in the Directory, and only the

names of the specialists certified by the American Boards will be included.

The Directory is to be the official publication of the Advisory Board for Medical Specialties and will be issued through the Columbia University Press in New York City. Plans for the Directory have been under way for nearly three years. It represents an effort officially to inform the lay and medical public regarding the present strong movement for certification of qualified medical specialists, and is expected to have wide use as a reference work in this respect.

Financial support has been given the Directory by the American Boards; the project is not designed to be profit-making, and the widest possible public distribution of the Directory is desired. On these accounts, the subscription price of the book has been set at a sum ($3.50 per copy) computed to cover only publication expenses.

The Directory should be invaluable to the entire medical profession in the reference of patients, as well as in many other ways, and the individual support of this new project of the American Boards is earnestly solicited of every Diplomate.

The Directory will be sold generally to physicians, libraries, hospitals, and others by subscription. Such subscriptions may be made through the Columbia University Press, 2960 Broadway, New York, N. Y., or through the office of the Directing Editor.

The Secretary of the American Board of Radiology wishes to urge that Diplomates of this Board and others interested in Radiology give their active support by subscribing to the Directory. This is direct support of the work of this, as well as of the other American Boards, as the Directory will be not only another strong instrument in the improvement of the standards of special medical practice in this country, but also constantly useful for reference in the office of any physician or hospital.

The Editorial Board consists of the secretaries of the fourteen American Boards. Dr. Paul Titus, 1015 Highland Building, Pittsburgh, Pennsylvania, Secretary of the Advisory Board, is the Directing Editor.

CONFERENCE OF EASTERN RADIOLOGISTS

The thirtieth annual midwinter Conference of Eastern Radiologists will be held in Poston, Massachusetts, with headquarters at the Hotel Statler, on January 26–27, 1940. The New England Roentgen Ray Society cordially invites all radiologists of the Eastern Seaboard to attend. The program will consist of contributions by members of the Boston City, Peter Bent Brigham, Beth Israel and Massachusetts General Hospitals. The first all day session on Friday will be held at the Hotel Statler with luncheon and the annual banquet at the Hotel. The Saturday morning session will be held at the Massachusetts General Hospital and in the afternoon the members are invited to visit the Massachusetts Institute of Technology.

A. O. HAMPTON,
Secretary
New England Roentgen Ray Society

Vol. 42, No. 6

DEPARTMENT OF TECHNIQUE

Department Editor: Robert B. Taft, M.D., B.S., M.A., 105 Rutledge Ave.
Charleston, S. C.

AN APPARATUS FOR STEREOSCOPIC ROENTGENOGRAPHY OF THE SKULL

By PAUL C. HODGES, M.D.
From the Division of Roentgenology, University of Chicago
CHICAGO, ILLINOIS

IMMOBILIZATION of the patient, careful arrangement of the beam of radiation relative to anatomic part and to film, and the employment of stereoscopic vision are factors desirable in roentgenography of any part of the body but particularly in the case of the skull. An experienced technician devoting considerable time to every patient will be able to produce good skull films with practically any type of commercial tube-stand or exposing table, but in laboratories where many skulls must be examined daily the work will be improved and expedited if special skull apparatus is provided. Numerous European and American workers have devised special apparatus for their own use but there is little apparatus of this sort commercially available in America at present.

My own interest in this matter began shortly before 1920[1] and has continued to the present. The apparatus here described was developed under my supervision by Mr. Raymond Angrabright and Mr. Stanley Doles in the Roentgenology Experimental Machine Shop of the University of Chicago. Its essential features had been established by 1934 but many of the details are of more recent design. During the period of development we have been willing to accommodate three sister institutions* by constructing or aiding in the construction of similar apparatus for them, and if other institutions or radiologists were to become interested presumably some manufacturer would be willing to produce identical or similar apparatus on a commercial basis. The apparatus is not patented and, of course, I have no commercial interest in it.

In the description that follows, certain conventions are observed in describing the angulation between the beam of radiation, the anatomic part and the roentgen film. The expression "radiation 60° toward feet (individual angles 57° and 63°)" means that for the making of a certain pair of stereoroentgenograms tube, patient and film were so arranged that the radiation passed from the tube obliquely downward and toward the feet of the patient, the angle between radiation and film being 57° for one, 63° for the other, the 6° shift providing the parallax necessary for stereoscopy. The expression "radiation 90° (individual angles 87° and 87°)" means that for another pair of stereoroentgenograms the radiation was directed perpendicular to the film except for the stereoscopic shift of 3° each way from center. This use of a 6° rotation of the tube arm to accomplish the stereoscopic shift avoids the necessity for additional gear in the tube support and allows us to use minimum size rectangular radiation ports.

GENERAL DESCRIPTION

Base, Masts and Body (*Fig. 1, A* and *B*). Rising from a cast iron base are two masts approximately 7 feet tall made from 3-inch steel tubing spaced 5½ inches apart, center to center. A cast aluminum body rides on these masts, counterbalanced by two 110-pound lead weights. A 4-

* University of Michigan, University of Pennsylvania, University of Iowa.

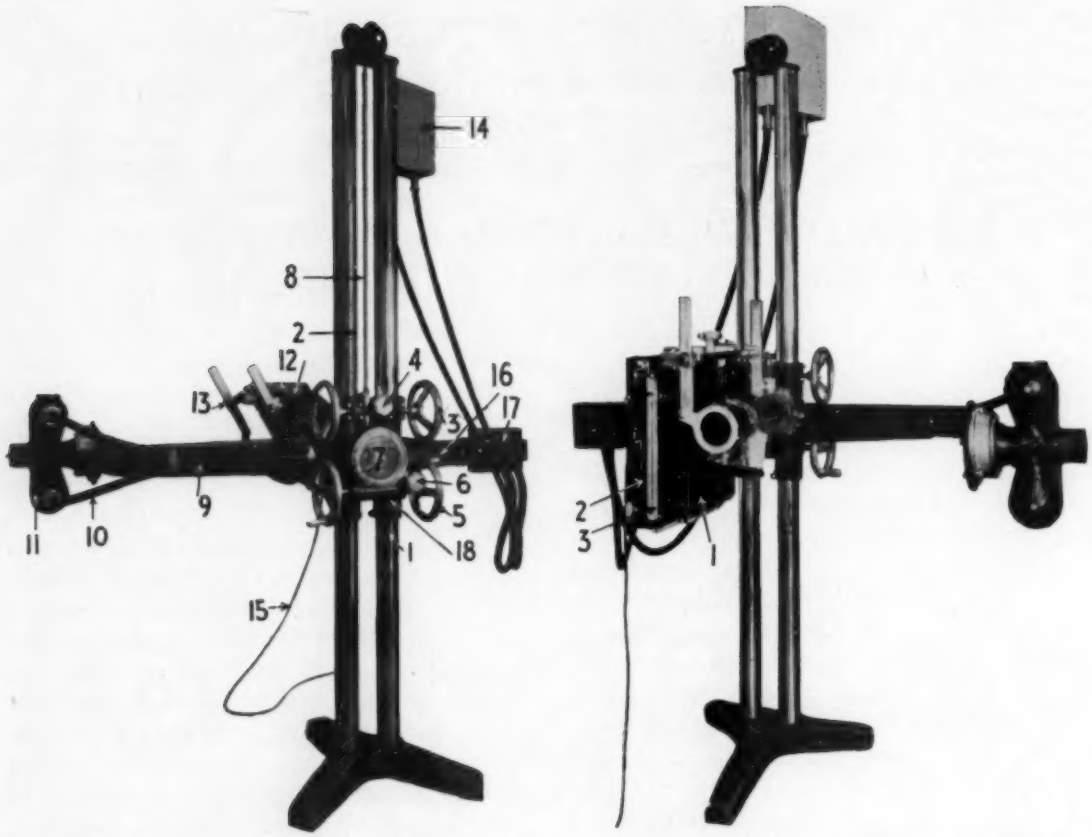


Fig. 1. Head machine. *A*, rear view. Machine set up for 60° sinus films, assembly rotated to the left 120° on Scale 1, tube arm parallel with film, radiation angled toward the patient's feet 60° relative to the film. *1*, mast; *2*, rack; *3*, hand wheel for elevating body; *4*, vertical lock; *5*, hand wheel of assembly gear; *6*, assembly lock; *7*, assembly dial; *8*, one of two chains to counterweights; *9*, tube arm; *10*, high voltage cables; *11*, roentgen tube; 12, Potter-Bucky grid; *13*, head clamp; *14*, high voltage junction box; *15*, low voltage cable for grid circuits; *16*, counterbalance strip; *17*, counterbalance weight; *18*, body.

B, frontal view. Machine set up for 90° sinus films. *1*, nose-board; *2*, tray opening; *3*, one of two brackets for attaching head clamp.

foot piece of rack screwed to one of the masts meshes with a small spur gear mounted on the body, and a shaft pinned to the gear passes through a clamping lock and is provided with aluminum hand wheels at either end. By means of these wheels and the lock the body can be moved up or down or can be locked at any desired point. One turn of the wheel moves the body about 5 inches.

Sleeve and Axle (*Fig. 2*). A steel sleeve 8 inches long, 1½ inches inside and 2 inches outside diameter is mounted in heavy tapered roller bearings within the body, one end projecting forward about 2 inches. Lying inside the sleeve is a 1½-inch axle about 15 inches long. An assembly of large aluminum castings called the "bed" is shrunk over the front end of the axle and a worm gear is attached near the rear end. The rear tip of the axle projects through a 7½-inch calibrated dial to carry a pointer that plays against the dial.

Arm Gear. A cast aluminum tube arm is pinned to the forward projecting portion of the sleeve and carries at its base a worm gear that meshes with a worm mounted on the bed, the ratio of worm to gear being 80:1. A jack shaft provided with hand wheels at either end operates through 2:1 herringbone gears to drive the worm. By turning these hand wheels the tube arm may be rotated relative to the bed. This mechanism is called the "arm gear" and because the ratio of hand wheel to gear is 160:1,

the system is self-locking. A pointer on the arm playing against a scale on the bed indicates the angular relationship between the two, the pointer standing at 90° when the radiation is directed perpendicular to the bed. It is mechanically possible to rotate the arm until the radiation is parallel with the surface of the bed but actually the smallest angle ever employed is approximately 57°.

Assembly Gear. The worm gear pinned to the rear of the axle meshes with a worm mounted on the body, and when the wheels attached to this worm are turned the whole assembly of axle, bed, sleeve and tube arm rotates as one unit in the roller bearings of the body (Fig. 2). This mechanism is known as the "assembly gear." In this case, since the ratio of worm to gear is only 50:1 it is necessary to provide a clamp lock. The 7½-inch dial of the assembly gear is calibrated in two halves: Scale I on the left, reading from 0° to 180°; Scale II on the right, also from 0° to 180°. When the bed is parallel with the floor the pointer stands at 0° and when it is rotated to the left until it stands perpendicular to the floor the pointer reads 90° on Scale I.

Bed and Plate for Potter-Bucky Grid. The bed consists of three aluminum castings bolted together. The rear casting, which is shrunk to the axle, matches with the drum-shaped center of the body and serves as a housing for the base of the tube arm and the arm gear. The tongue-like anterior casting projects forward to serve as a bed for the Potter-Bucky grid and is slotted to receive a pivot extending downward from the fenestrated cast aluminum plate that carries the Potter-Bucky grid. The Potter-Bucky grid, of standard commerical design except that it is designed for a target-film distance of 36 inches, is permanently bolted to the plate but the plate is attached to the bed only by means of a pivot that passes through the slot to be secured by a heavy hand-operated nut. In the normal operating position the grid is arranged with its grid members parallel with the plane of rotation of the bed and with the plane of movement of the tube arm, its tray opening being at the side. The tray opening can be placed above rather than at the side by loosening the hand nut, pulling the grid forward, rotating it through 90°, shoving it back until it is in contact with a shoulder on the bed and then

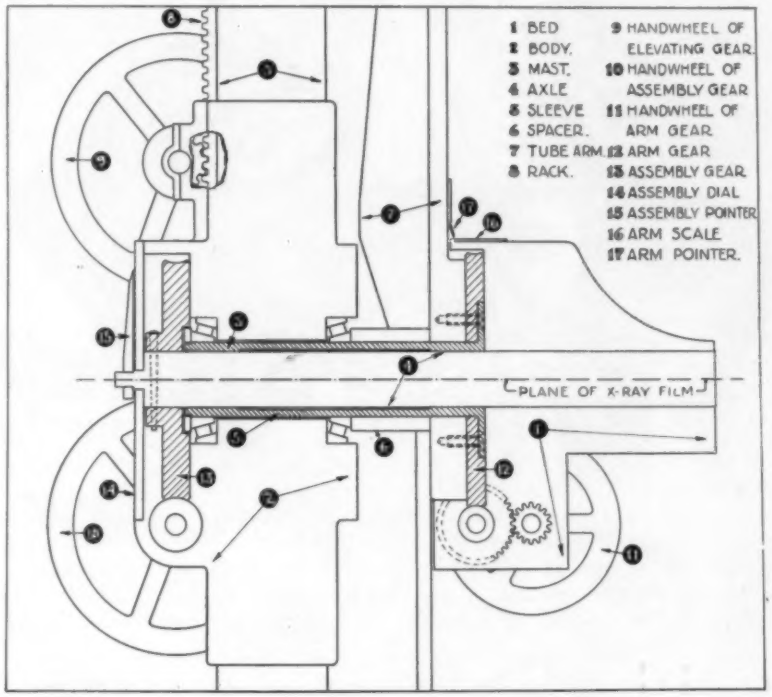


Fig. 2. Diagram of sleeve and axle assembly.

locking it with the hand nut (Fig. 3). In this position (useful for certain special examinations) the grid members lie perpendicular to the plane of rotation of the bed.

Tube Arm. At its upper end the cast aluminum tube arm projects forward about 18 inches to form a base for the roentgen tube. A heavy lead plate located in this base is pierced by a port approximately 2 inches square through which the beam of radiation emerges. Unlike conventional circular cones, rectangular tube level ports are out of the way and allow restriction of unwanted radiation to a minimum. It is true that the margins of the shadows cast by them are blurred and irregular but this difficulty may be overcome by having the beam large enough so that its border just fails to show on the film. The center of the beam of radiation falls at the center of the film, regardless of whether the grid is in the normal position or has been rotated 90° and regardless of the angular relationship between arm and bed. For exacting work on smaller films, special small ports are inserted in a groove beneath the built-in port.

Extending downward from the base of the tube arm is a steel strip approximately 26 inches long carrying a 46-pound counterbalance weight. The high voltage cables approximately 15 feet long pass from the tube to be anchored along either side of the rib at the back of the tube arm. In the gear housing they pass at either side of the sleeve to be anchored again to the counterbalance support. The two sides of the housing are removable so that the cables can be laid into position at either side of the sleeve. From their last point of attachment at the counterbalance weight the cables loop free through the air up to a junction-box located near the ceiling.

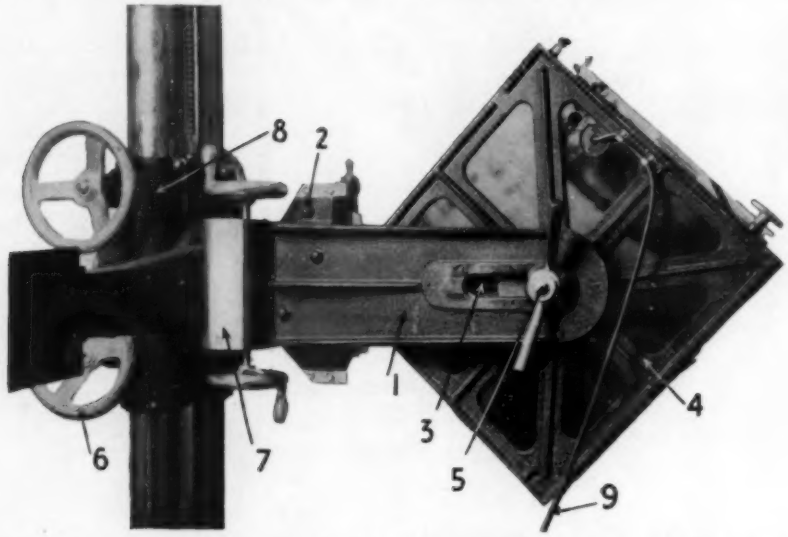


FIG. 3. Head machine—view of bottom of bed. The bed has been rotated to 90° on Scale 1 and the hand nut has been loosened to indicate the means of rotating the grid from the normal position into the special position. In the illustration the grid is halfway between the two positions. *1*, tongue-like portion of bed; *2*, housing portion of bed; *3*, slot in bed; *4*, grid plate; *5*, hand nut on pivot; *6*, hand wheel of assembly gear; *7*, lower housing of assembly gear; *8*, body; *9*, low voltage cable for grid circuits.

ACCESSORIES

Table, Wheel, Stretcher and Stool. As far as the machine itself is concerned, examination of the skull may be made with the patient in any desired position. For the making of optic foramen films, Stenvers films and the routine examination of the skull, we in our laboratory prefer to have the patient recumbent rather than erect. Unlike many other workers, we prefer the recumbent position also for pneumograms, finding the technical disadvantages slight and the practical advantages great since such patients are always apprehensive, usually more or less uncomfortable and frequently partially or completely anesthetized. Either a wheel stretcher or a mattress-covered table is used, the height of the grid being adapted to the height of the surface on which the patient lies. With the aid of a transparent bakelite shelf attached to the end

of the table one may, if he wishes, make "upside down" pneumograms, but to my mind this maneuver involves difficulties in centering and immobilization that outweigh any possible advantage there may be in having the upper surface of injected air close to the film.

For sinus films the patient sits on an ordinary adjustable laboratory stool.

Head Clamp. The head clamp (Fig. 4) differs from commercially available clamps in the following respects:

(1) The portions that overlie the film consist of sponge rubber and balsa wood and therefore show only faintly in roentgenograms of infants and not at all in adults.

(2) The base of the clamp serves also as the upper support for nose-boards and axial view plate.

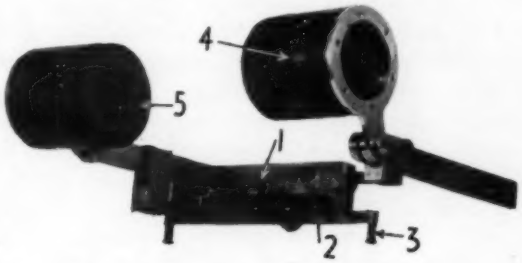


Fig. 4. Head clamp. *1*, body of clamp; *2*, support for nose-boards; *3*, hardened pins for attaching head clamp to bracket; *4*, balsa wood cylinder; *5*, sponge rubber ring.

(3) The bracket for attaching the clamp to the grid is rugged, simple and quick acting, and when the clamp has been removed no portion of the bracket projects above the surface of the grid.

(4) When the bracket is not serving as the attachment for the clamp it may be used to attach the optic foramen board, the Stenvers board or the mastoid board.

(5) Twelve-inch discs of flexible cellophane-like material* are gathered over the sponge rubber rings and the balsa cylinders and held in place by rubber bands. These protective covers may be washed with alcohol or with soap and water and, being cheap, may be replaced frequently.

Compression Bands. A compression band device permanently attached to the bed is used regularly in connection with the optic foramen board, the Stenvers board, the mastoid board and sometimes in conjunction with the head clamp in other examinations, particularly on unruly patients. A second compression band device that can be slipped over a rod at the bottom of the grid is employed only for special pneumograms.

* "Merchandise Protector" manufactured by Richards, Boggs and King, Inc., Chicago, Illinois.

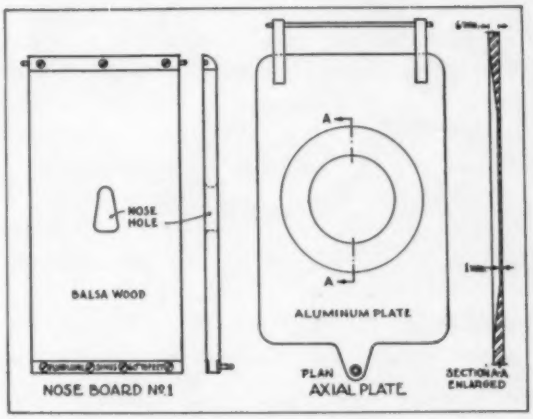


Fig. 5. Nose-boards and axial plate.

Film Dividing Tunnel. For optic foramen films, Stenvers films and certain others we use divided 8″ × 10″ films exposed and processed as units but cut into two 5″ × 8″ films for study on the stereoscope. For this work a film dividing tunnel takes the place of the conventional grid tray.

Nose-Boards (Fig. 5). It has long been recognized that in those views of the skull in which the patient's face is against the film a nose-board provides an excellent means for orienting the skull relative to the center of the film. We employ three such boards made of 5/8-inch balsa wood approximately 8 inches wide and 16½ inches long and provided with metallic anchoring devices at either end. At its upper end each board locks into the base of the head clamp and at its lower end there is a heavy case-hardened pin that enters a slot in the lower edge of the grid where it is secured by a spring catch. These boards differ from one another solely in the relationship between the base of the nose hole and the transverse axis of the film. In all of them the center of the nose hole lies on the longitudinal axis.

Vertex Block (Fig. 6). A hard wood block 5 5/8 inches long, 2 inches thick and truncated at one end and one side to clear protuberances on the head clamp is used to locate the vertex of the skull for occipital films and lateral films. When the vertex is 5 5/8 inches away from the

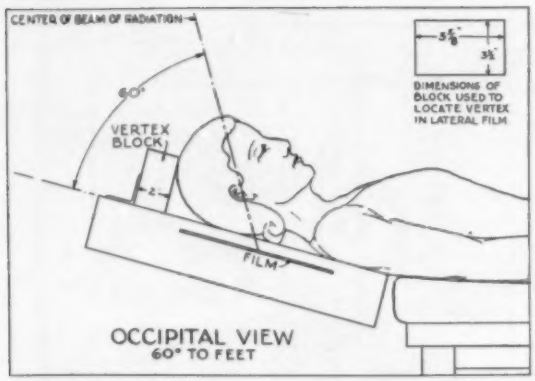


FIG. 6. Arrangement of skull, film and beam of radiation for occipital view.

base of the clamp, it lies 2½ inches above the transverse axis of the film. When it is 2 inches away from the clamp, it is 6 3/8 inches above the center of the film.

Optic Foramen Board (*Fig. 7*). The optic foramen board is made of masonite ¼ inch thick, 14 inches wide and about 20½ inches long, provided with case-hardened pegs at either end for engagement in the bracket ordinarily used to hold the head clamp. A wedge-shaped balsa wood block in which one face makes an angle of 45° with the base is cemented and doweled to the upper surface of the board so that the lower edge of the oblique face of the block is parallel with the longitudinal axis of the film and displaced 1½ inches away from this axis. A heavy white line indicates the location of the longitudinal axis on the board and a second one extending across the board and up over the center of the inclined face of the block indicates the location of the transverse axis.

Stenvers Board (*Fig. 7*). The Stenvers board is identical with the optic foramen board except in the following particulars:

(1) The lower edge of the inclined face of the block instead of being displaced aawy

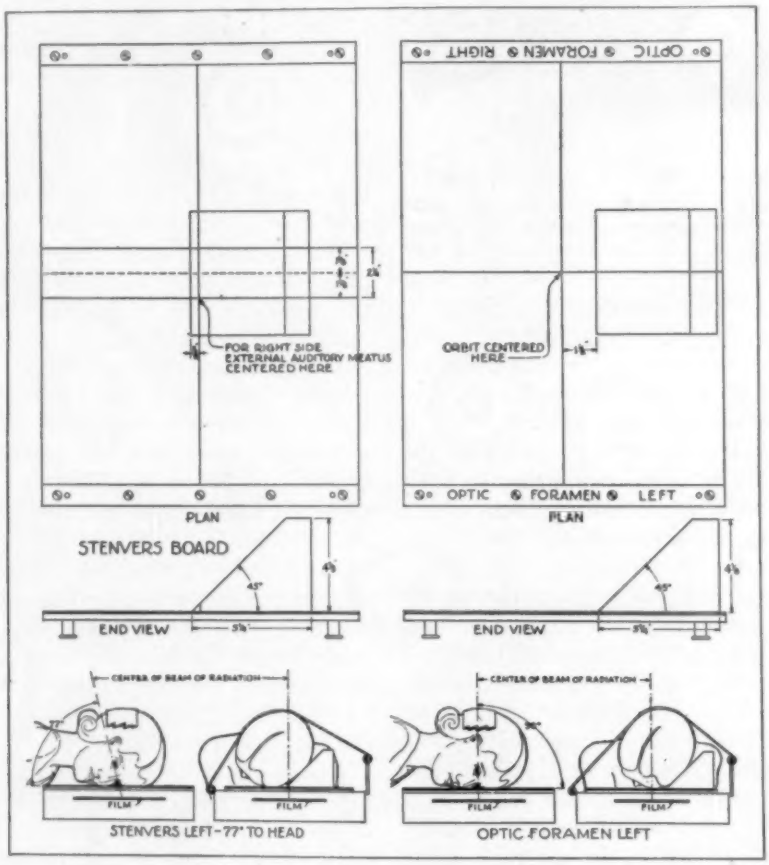


FIG. 7. Arrangement of skull, film and beam of radiation for optic foramen view and Stenvers view.

from the longitudinal axis overlies it 3/8 inch.

(2) Two parallel white lines 2¼ inches apart and equidistant from the transverse axis indicate the level at which the external auditory meatus should be placed. Since the radiation is angled toward the head the center-point for the meatus is below the transverse axis of the film.

Mastoid Board. The mastoid board is identical with the Stenvers board except in the following respects:

(1) The balsa wood block is larger, having a base 5½ by 7 inches. The inclined face makes an angle of only 15° with the base and the lower edge of the inclined side overlies the longitudinal axis 2 inches.

(2) Two parallel white lines 2½ inches apart and equidistant from the transverse axis indicate the level at which the auditory meatus should be placed. In this case, since the radiation is angled toward the feet the center-point is above the transverse axis of the film.

Axial Plate (*Fig. 5*). The axial plate consists of a sheet of aluminum 6 mm. thick and 10 inches wide, provided at its upper and lower ends with anchoring devices similar to those used on the nose-boards. A saucer-like depression 7 3/8 inches in diameter at the rim and 4½ inches in diameter at the bottom has been turned into the surface of the plate, the thickness of aluminum at the bottom being only 1 mm. The center of the saucer coincides with the center of the film.

OPERATION OF MACHINE

Sixty-Degree Sinus View (*Fig. 9*). The head clamp is attached to the grid, the grid is turned into the normal working position with the grid members parallel with the plane of rotation of the tube arm, and nose-board No. 1 is attached. In this nose-board the base of the nose hole lies ¼ inch below the transverse axis of the film. The bed is rotated to the left until the pointer stands at 120° on Scale 1—in other words, the bed is rotated through the 90° position until the grid and the film make a reverse angle of 30° from the perpendicular.

The patient extends his neck to accommodate for the angulation of the grid and the grid is raised or lowered until the nose fits in the nose hole. The head is immobilized with the clamp. The tube arm is rotated so that the radiation is angled toward the feet of the patient at a mean angle of 60° relative to the film (individual angles 57° and 63°), but the angle of the film is such that this brings the beam of radiation parallel with the floor so that if free fluid is present in the antra or the frontal sinuses gravity levels will show.

Frontal View of Sinuses (*Fig. 1B*). Nose-board No. 2 is used, in which the base of the nose hole lies 2½ inches below the transverse axis of the film. The bed is rotated until the pointer stands at 90° on Scale 1. The patient sits erect, the head is immobilized with the clamp. Radiation is directed parallel with the floor and perpendicular to the film (individual angles 87° and 87°). This view is particularly useful for examination of the orbits, the ethmoids and the sphenoids. For small subjects divided 8″×10″ films are used; for others, full 8″×10″ films. If free fluid is present in the sinus, gravity levels will be demonstrated.

Frontal View of Skull. Nose-board No. 3 is used, in which the base of the nose hole lies 3½ inches below the transverse axis of the film. Usually the patient lies prone but he may sit on the stool with the grid at 90° to the floor or rotated into a smaller angle if that is more comfortable for him. The mean angle of radiation is 83° toward the head (individual angles 80° and 86°); 8″×10″ films are used.

Occipital View (*Fig. 6*). The patient lies recumbent on the table. The grid may be flush with the top of the table but the patient is usually more comfortable if it is elevated slightly and angled slightly forward. The chin is flexed as sharply as possible, the vertex is brought up against the 2-inch thickness of the vertex block, following which the head is immobilized by means of the head clamp and sometimes also the compression band. When this has been done the block is removed and stereoscopic 10″×12″ films are made at a mean angle of 60° toward the feet (individual angles 57° and 63°).

Lateral View. The patient lies prone on the table, the grid surface being arranged flush with the table top. The neck is rotated until the right side of the skull is in contact with the film, the vertex being

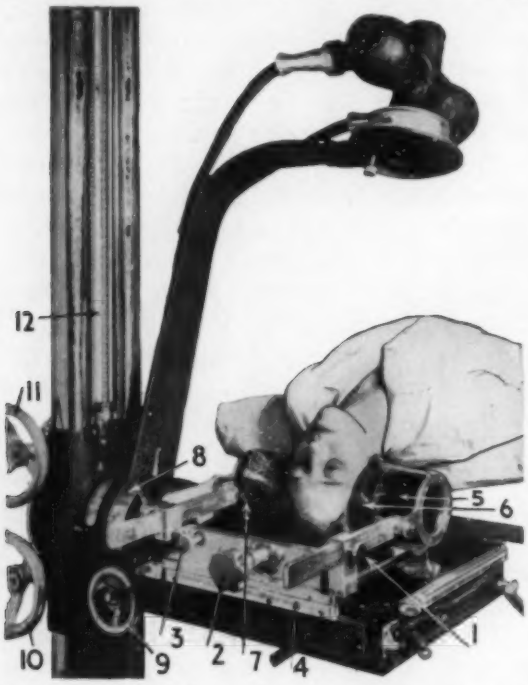


Fig. 8. Head machine set up for axial view. *1*, axial plate; *2*, operating knob of head clamp; *3*, locking screw of head clamp; *4*, bracket for head clamp; *5*, balsa wood cylinder; *6*, sponge rubber ring; *7*, protective covering; *8*, scale on bed indicating angular relationship between arm and bed; *9*, operating wheel for arm gear; *10*, operating wheel for assembly gear; *11*, operating wheel for spur gear of elevating device; *12*, chains to counterweights.

positioned by means of the $5\frac{5}{8}$-inch thickness of the vertex block. When the skull has been manipulated until its sagittal plane is parallel with the film and immobilized by the head clamp, stereoscopic 10″×12″ films are made with the films crosswise, the mean angle of radiation being 90° (individual angles 87° and 87°). The process is repeated with the left side down.

Axial View (*Fig. 8*). The axial plate is placed on the grid and the grid is lowered until its upper surface is approximately 4 inches below the surface of the table. The patient lies supine on the table, a pillow beneath his shoulders, his head hanging over the end of the table, his neck extended as far as possible and the vertex of his skull placed at the center of the depression in the axial plate. The head is immobilized with the head clamp, sometimes with the additional aid of the compression band. In the ideal case the radiation is directed at 90° to the film but actually few patients can extend their necks sufficiently, and to assure that the beam will pass beneath the mandible usually one must angle the radiation somewhat toward the patient's head. In the average case the mean angle is 75° (individual angles 72° and 78°); 10″×12″ films are usually employed.

The axial plate serves two purposes. First, it is a centering device for the vertex; second, a wedge-shaped filter to prevent overexposure of the tissue at the circumference of the skull without interfering with adequate exposure of the deep structures.

Optic Foramen View (*Fig. 7*). The head clamp is removed and the optic foramen board placed on the bracket with the block at the right. The patient lies prone on the table, his head turned so that the right side of his face makes an angle of 45° with the plane of the film. The head is now manipulated against the inclined surface of the balsa wood block until the center of the orbit lies on the white line indicating the transverse axis of the film, and the brow

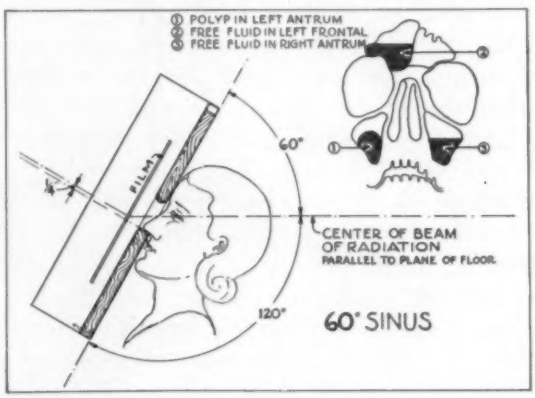


Fig. 9. Arrangement of skull, film and beam of radiation for 60° sinus view with diagram of type of film obtained.

and chin are pressed firmly against the block and the board. Immobilization is accomplished by means of the compression band. Halves of 8″×10″ films are used. The mean angle of radiation is 90° (individual angles 87° and 87°).

For the left optic foramen the board is attached by the opposite end so that the balsa wood block lies at the left.

Stenvers View (*Fig. 7*). For Stenvers view of the apex of the petrous pyramid,[2] the head clamp is removed and the Stenvers board substituted for it, the balsa wood block being at the right for the right temporal bone. The patient lies prone on the table, his head rotated until the right cheek forms an angle of 45° with the plane of the film.The head is now manipulated until the right external auditory meatus lies on the white line 1⅛ inches below the transverse axis of the film, and the brow and chin are pressed firmly against the block and board. Immobilization is accomplished by means of the compression band. Halves of 8″×10″ films are used. The mean angle of radiation is 77° toward the head(individual angles 74° and 80°).

For the left temporal bone the board is attached by the opposite end so that the balsa wood block lies at the left.

Mastoids. With the grid in the normal position the head clamp is removed and the mastoid board attached to the bracket so that the balsa wood block lies at the right. The patient lies prone on the table, his right cheek making an angle of 15° with the plane of the film, his right external auditory meatus lying on the longitudinal axis and 1¼ inches above the transverse axis. Immobilization is accomplished by the compression device. Radiation is angled toward the feet at a mean angle of 75° (individual angles 72° and 78°).

For the left mastoid the board is attached by the opposite end so that the balsa wood block lies at the left.

Special Pneumograms. When routine filming has raised the suspicion of a lesion involving the tip of the anterior horn of the lateral ventricle, special films are sometimes indicated. The bed is rotated until the film stands at 90° to the floor and the grid is turned on its pivot so that the tray opening is above rather than at the side. The head clamp is removed and the special compression device is slipped over the rod at the lower edge of the grid. The table is swung at right angles to its normal position and the patient lies supine with his head hanging over the end of the table, the right side of his head against the film, the vertex pulled out onto the film as far as the relationship between his right shoulder and the side of the grid will permit. The head, with the neck extended as far as possible, is held against the film by the special compression device and radiation is directed parallel with the floor and perpendicular to the film (individual angles 87° and 87°).

For lesions of the posterior horn the position is reversed with the patient prone, his neck flexed, the left side of his head against the film.

Since in these special views the stereoscopic shift is across the grid strips there is more "cut off" of radiation than normal and grid lines are apt to show in the films but these difficulties are minimal since the mean angle is 90°.

CLINICAL APPLICATION

In recent years numerous publications[3,4,5] from our institution have presented skull roentgenograms that were made on this apparatus.

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ELECTRICAL PROTECTIVE DEVICES IN RADIUM WORK

By JACK DE MENT
PORTLAND, OREGON

THE dangers accompanying actual manipulation of bare radium salts and containers of radium are well known to most of those who have ever done work in this field. Lead has usually been the mainstay for protection during actual exposure of the medical operator or investigator to radioactive materials. But in certain procedures, especially those of research and experimental techniques, lead often restricts work and is subsequently often discarded at the expense of the worker.

While the devices described in this paper are not wholly protective, they tend to reduce the hazard greatly and facilitate work with much greater ease than might have been performed previously. The use of the simple electrical principle is not restricted to medical operators alone but may be extended to the field of radioactive workers who are involved in actual isolation and separation of the salt for commercial purposes, physicists and chemists who handle the material, and any other special workers who are exposed to the dangerous substance.

Radioactive materials emit three basic radiations or particles to which their power is attributed. First are the relatively sluggish alpha particles which carry a positive charge. The faster and more penetrant beta particles carry a negative charge. The alpha particles are helium ions while the beta particles are fast electrons. Both are used in radiotherapy to a varying extent. The alpha and beta particles are both small units of matter. The weight of an alpha particle is about 6.60×10^{-24} gm. A beta particle weighs about 5.50×10^{-4} at. wt. The third emission from radioactive materials constitutes the radiation termed the gamma ray. This gamma ray is nothing other than an extremely short roentgen ray. Extremely hard (short wave length) gamma rays will penetrate many centimeters of lead while the hardest beta particle is stopped by a thin sheet of lead. Paper and air will completely absorb alpha particles. In every case the penetration power of each of these radiations or particles varies considerably. There are soft gamma rays just as there are soft roentgen rays. In all, several hundred degrees of hardness have been recognized in the gamma ray alone. The gamma radiation carries no charge. A rough ratio between the penetrant powers of each of these rays is given as 1/100/1000 for alpha, beta, and gamma rays respectively.

In my own laboratory work has necessitated the use of bare radium salts and results are often modified if I attempt lead protection. I have found that a simple electrical device may be used to eliminate or reduce the hazard from alpha and beta particles. It will be found that the gamma ray cannot be eliminated by this method as it depends upon the fundamental law of electrical attraction and repulsion. Briefly, this law states that *like charges will repel while unlike charges will attract.* In Figure 1 the effects of this law upon the particles emitted from a radioactive substance will be noted. This diagrammatic sketch, first introduced by Madame Curie, demonstrates that the negatively charged beta particles are attracted enormously to the positive pole in a magnetic or electrical field. The positively charged alpha particles are attracted, to a lesser extent, to the negative pole in a magnetic or electrical field. The gamma radiation being neutral and non-material is not affected by the strongest field. It might be noted that the relatively greater effect of a field upon the medically significant beta particles is advantageous from our electrical protection standpoint. The alpha particles are affected

very little by the field but their low penetration makes this an insignificant fact relative to the protective principle.

The electromagnetic radium protection principle is illustrated by Figure 2. The radioactive particles are diverted from their course by magnetic poles or electrically charged plates. It is obvious, then, that the field occupied by the operator is protected from an excessive bombardment by radioactive particles.

Using this principle, a machine was constructed consisting essentially of two large metal plates which were charged with a high potential. The plates were always placed at right angles to the worker's body. The radium and its manipulation was carried on in the uniform field between the plates. A large amount of beta particles were attracted to the positively charged plate while the alpha particles transmigrated to the negatively charged plate. In any case, with a sufficiently high potential, a large amount of the two radioactive particles could be diverted from the worker's body. The gamma rays being uncharged were not affected. Figure 3 is a diagrammatic representation of a simple protective device. The housing, *1*, contains

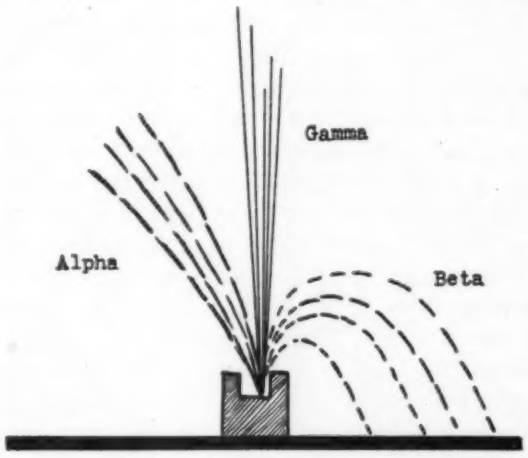


Fig. 1. Basic principle involved in electromagnetic protection. Negatively charged beta particles are attracted to the positive magnetic or electric pole. Positively charged alpha particles are attracted to the negative magnetic or electric pole. The neutral gamma rays are unaffected by either field.

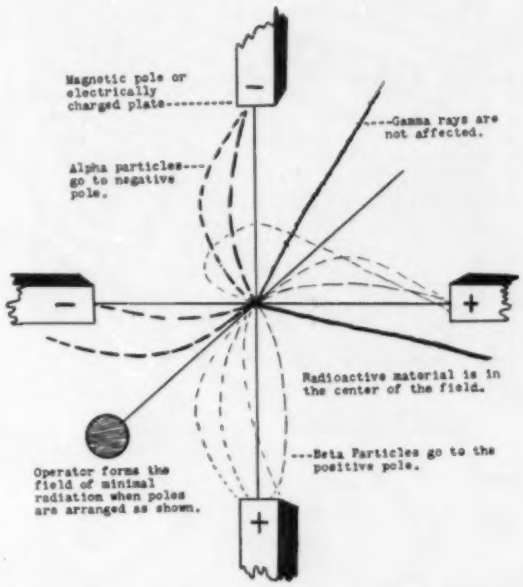

Magnetic pole or electrically charged plate
Gamma rays are not affected.
Alpha particles go to negative pole.
Radioactive material is in the center of the field.
Beta Particles go to the positive pole.
Operator forms the field of minimal radiation when poles are arranged as shown.
−
+
−
+

Fig. 2. Diagrammatic representation of electromagnetic protection. Operator is protected from alpha and beta particles.

a small 10 kv. transformer or coil, *2*. This step-up instrument is energized by lead-ins of 110 volts. Batteries may be used, being obviously dependent upon the type of coil or transformer. The plane copper plate, *3*, is connected to the output side of the coil by conduit, *5*, all being insulated by block, *4*. An extension, *6*, of the housing, forms a protective shell protecting the operator from undue and annoying shocks. The clearance at any point on the plate should exceed the maximum sparking distance of the coil. No. *7* is a metal plate forming the other half of the electrical field. In the instrument shown the plate is grounded, *8*. The distance, *D*, between the two plates will vary as to the condition. The strength of the radioactive preparation, positive-negative differentiation, applied kilovoltage, and of course *D* will determine the relative effectiveness of the instrument. Although theoretically positive and negative poles are required in this protective principle the strict adherence to the positive-negative differentiation is not required as results are obtained with simple 10,000 volt transformers. The machine in Fig-

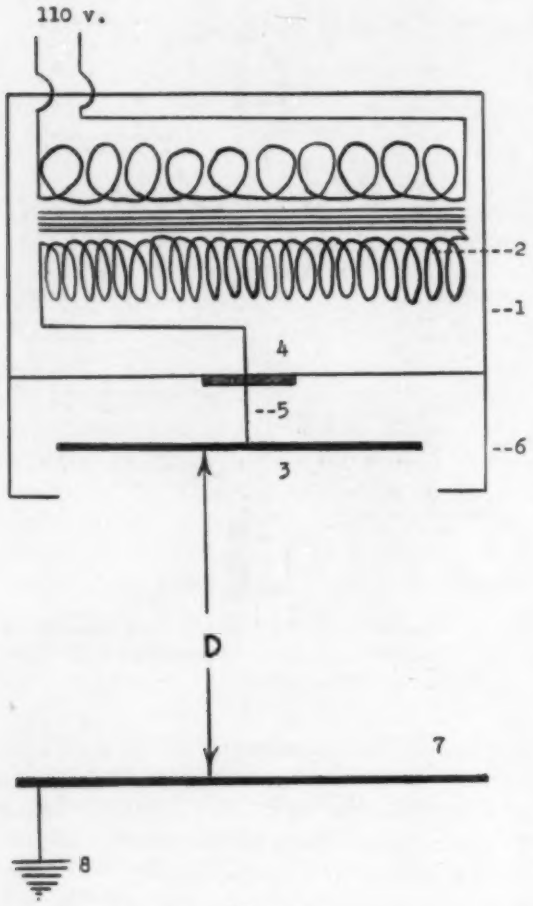


Fig. 3

ure 3 uses such a transformer (or coil) to energize the plates. It is obvious that this device may be modified by using charged wires, brushes, plates, poles, foils, and so on. When using the transformers the live side is connected to the plate and the other side is grounded. By this method only one plate may be used. Care should be exercised to fix the position of the plates so that the particles are thrown in directions other than that of the body of the operator or object to be protected. A plate may be fixed so as to throw particles up or to the side, depending upon its position, and throwing the other particle to the other side or into the ground.

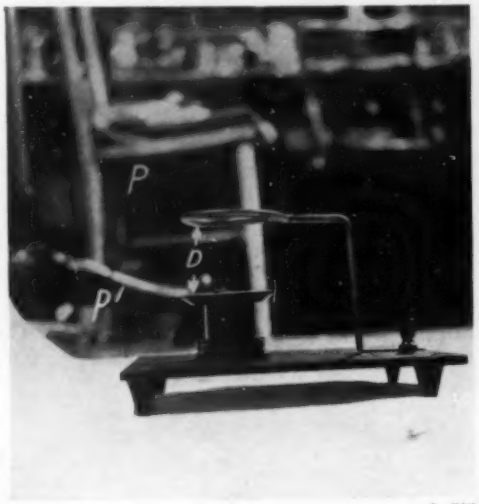
Correlation of the described apparatus with lead sheets will allow gamma rays to be taken out of the field of protection.

Care must be exercised to insulate portions of the plates or collection electrodes so that annoying shocks may be eliminated. Mechanical methods must be used to protect the operator as any interposition of a dielectric will modify the field between the two plates. The use of rubber, plastic, or wood shells will insure safety, and while these shocks are not dangerous to life they will reduce efficiency. The operator may come in contact with one side of the plate, regardless of charge, at any one time without being shocked. It is obvious, then, that the required insulation must be directed to the other plate so that there may be no danger of the body closing the circuit. This may be said to hold true for the floor which the man is in contact with. Rubber mats will prevent a short-circuit through the earth. Experience has shown that boxing the upper electrode on the outer and upper extremities, thus leaving the bottom open, will protect the operator from shocks no matter how intimate the contact may be. In table devices, used in fractionation of radium salts, screening the highly charged overhead bar will prevent any discharge that might shock. In this table arrangement the top of the table is grounded(metal) and an overhead bar forms the opposite pole.

My laboratory arrangement consists of a vault extending 10 feet into the ground, the active salts being suspended in lead capsules on chains. The mouth of the vault consists of a lead-glass bowl such as is used in roentgenologic work and a charged bar arrangement which is placed so as to throw particles up and to the side. The bar is energized with a small 8 kv. transformer. The other pole of the transformer is grounded. By such an arrangement the lead equivalent during storage is at a minimum of 1 ton. During handling the operator receives only a small amount of gamma radiation and possibly fractions of each of the particles. The current is closed when the materials are brought up and out of the vault.

Figure 4 shows a small experimental machine which has been detached from

its protective shell which surrounds the live plate, *P*, the upper one. The binding post in back facilitates connection to the transformer or coil. *D* is the active field and working space. *P'* is the ground plate and upon it the manipulations with radioactive materials are performed. A small capsule is lying on this plate *P'*.



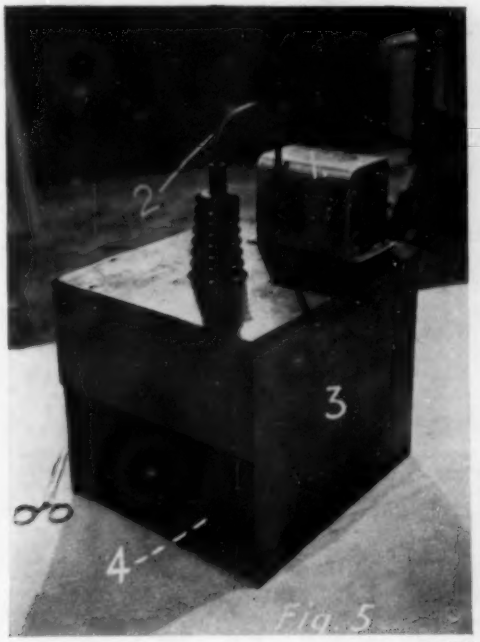
L. Zill

Fig. 4

Figure 5 is an enclosed form of apparatus used in general radioactive work. The plates are not visible but are energized by coil, *1*, which has cable, *2*, to lead the current directly to the plate which is in and up relative to the box, *3*. The entrance to the machine is at *4*.

The use of powerful magnets, preferably those of the electromagnet type, may be used instead of charged plates. The electromagnet is non-shocking and may be used at a closer range with possibly more power than the electric plate. The magnetic arrangement obviously precludes the use of ferruginous materials which will be strongly attracted by the field. In such cases the use of non-magnetic alloys for capsules and forceps is required. The particle throwing precautions observed with the electrical systems can be noted with magnetic fields.

In summarizing, I might state that the use of charged metal plates, etc., or the use of strong magnetic fields will reduce the



L. Zill

Fig. 5

danger of over-exposure to alpha and the much more hazardous beta particles. Obviously these particles must be thrown from the body in any one of the many possible forms of apparatus utilizing these principles. These devices will not affect the gamma ray but by coördinated use of lead and electrical or magnetic protectors the whole radium exposure hazard may be reduced considerably.

The electric or magnetic protection principle in radioactive work depends upon the fact that positive particles may be diverted from their original emission path and absorbed upon a negatively charged electrical or magnetic pole. Negative particles will then be affected similarly by a positive electrical or magnetic pole. These particles will be thrown from or repulsed by charges that are the same as they themselves carry. Alpha and beta particles from radioactive sources as well as protons, both positive and negative, positrons and electrons, and positive and negative barytrons *theoretically* would be affected by such devices while gamma rays, roentgen rays, neutrons, neutrettos, and neutrinos would not be affected.

INDEX TO ABSTRACTS

ROENTGEN AND RADIUM THERAPY

Freund, F.: The mechanism of action of roentgen rays on inflammatory processes. 934

von Wieser, W.: Fundamentals of roentgen therapy of inflammations. 934

Wintz, H.: The conservative treatment of inflammations of the female genital organs by the aid of roentgen rays. 935

ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN AND RADIUM THERAPY

Freund, Franz. Über den Wirkungsmechanismus der Röntgenstrahlen auf Entzündungsprozesse. (The mechanism of action of roentgen rays on inflammatory processes.) *Strahlentherapie*, 1938, *62*, 156–158.

The understanding of the roentgen effect on inflammations is more difficult than that of the effect on carcinoma. While it is assumed that in carcinoma the roentgen rays destroy the carcinoma cells, in the presence of an inflammation this destructive effect of the radiation is lacking. The repeated use of small doses suggests the assumption that small amounts of roentgen rays have a favorable effect on the cells. Some authors have assumed that roentgen rays increase the bactericidal powers. However, roentgen irradiation produces the same curative effect also in aseptic inflammations where there is no question of bactericidal power.

An attempt is here made to discuss the mechanism of influence of roentgen rays on the basis of experimental studies carried out by this author:

The carcinomatous as well as the inflammatory tumor consists of endogenous body cells. In the inflammation these tumor cells, in cases when one deals with suppurative inflammations, are destroyed spontaneously in that a perforation occurs externally or the pus is absorbed. In the non-operative forms of inflammation these tumor cells are capable of leading to a spontaneous healing by the process of fibrosis, a condition which never occurs in carcinomatous tumor cells. Roentgen irradiation leads in carcinomatous as well as in inflammatory tumor tissue to fibrosis and consequently to healing. In many cases also the inflammatory tumor cells lead a destructive life of their own; reference is had here to various forms of tuberculosis, pneumonia, osteomyelitis, phlegmons, etc. In such malignant forms of inflammation the roentgen rays change the course and favor fibrosis and consequently healing. In the suppurative forms of inflammation there occurs at first a decomposition of leukocytes while at the same time the new formation of pus cells is prevented. The above is based on the assumption that the pus cells are pre-existent at the point of inflammation in another form and as a result of the irradiation are prevented from being transformed into pus cells.—*A. S. Schwartzman.*

von Wieser, W. Grundlagen der röntgenologischen Entzündungstherapie. (Fundamentals of roentgen therapy of inflammations.) *Strahlentherapie*, 1938, *62*, 143–150.

As early as 1903 Leopold Freund reported on the successful results obtained from the treatment of inflammatory diseases with roentgen rays. Inflammatory conditions are therefore one of the oldest indications of roentgen therapy. Even though roentgen therapy has been used in the treatment of inflammatory diseases for many years the theoretical part of the problem has not been worked out. This is, according to this author, partly due to the fact that the problem has always been considered as a whole and partly due to the fact that the individual authors failed to separate the problem into its individual units chiefly because each one at-

tempted to obtain the same purpose, namely, a cure of the inflammation. A study of the literature shows that in regard to dosage both extremes, namely, very small and very large doses were used. The intermediate doses, however, are also effective. The question arises, how is one to explain this peculiar behavior? The answer is partly as follows: At first it must be remembered that the different noxae, which produce inflammations may be influenced by different doses. This could be expected since inflammations which are conditioned by infections would also react differently depending on the type of bacteria which produced the infection; however, this is not the case. The studies of Wagner and Schonhoff have shown that the roentgen rays do not possess a bacteriolytic effect. These authors were unable to demonstrate any bactericidal power in the roentgen treated pus or blood serum and failed to find a destruction of gonococci following an irradiation of the mucosa infected with gonorrhea. Even at present it is impossible to destroy bacteria *in vitro* with the highest roentgen doses. The different sensitiveness of bacteria, therefore, does not explain the different roentgen doses necessary in the treatment of the different infections. The next possible explanation would be the assumption of the difference in the structure of the mother tissue in which the inflammation occurs as responsible for the different sensitiveness to roentgen rays. The difference in structure would explain the small differences in the dosage used but would not explain the extreme difference in dosage used in the treatment of inflammations. Marburg and Sgalitzer used 70 to 80 per cent skin unit dose per focus in irradiating hydrocephalus irrespective of whether the hydrocephalus was conditioned mechanically, was due to hypersecretion or to an inflammatory hypersecretion. This author used 1 to 2 per cent S.U.D. per focus in the treatment of hydrocephalus of an inflammatory origin. In the treatment of mastitis the dosage of roentgen rays used by different authors varies from 2 to 80 per cent S.U.D. In spite of that all these authors reported to have obtained good results by these different methods and there is no reason to doubt the reports.

Some authors have rationalized the use of high doses by the necessity of the exclusion of function of the diseased organ.

There exist, therefore, two distinct methods for the treatment of inflammations: The exclusion of function of the diseased organ and the direct influence of the inflammation. Since the first mentioned method could be applied only to the cases where an organ function which is accessible to roentgen influence exists, this method is limited only to such organs.

The question arises as to why a large roentgen dose used for the exclusion of the function of a given organ does not lead to a propagation of the inflammation, especially since it is known that occasionally the use of a large dose may give rise to stormy roentgen symptoms irrespective of the nature of the organ irradiated. This would indicate that there exists a more important difference between a slight and a great reaction of a given dose.

Von Wieser is of the opinion that a difference in the reaction of the tissue is not conditioned by the special peculiarity of a given organ but is limited to the body as a whole and he substantiates this statement by the common observation that under similar conditions similar doses may give rise to very severe reactions in one individual and to practically no reaction in another. He states that the reaction ability and the type of reaction of inflamed tissue depend on the following factors: (1) on the stage of the inflammation; (2) on the amount of connective tissue present; (3) on the vascular supply and the condition of the vessels, and (4) on the vegetative nerve supply.—*A. S. Schwartzman.*

Wintz, H. Die konservative Behandlung der Entzündungen der weiblichen Genitalorgane unter Zuhilfenahme der Röntgenstrahlen. (The conservative treatment of inflammations of the female genital organs by the aid of roentgen rays.) *Strahlentherapie*, 1938, *62*, 159–166.

The conception of inflammatory diseases of the female genital organs includes a series of diseases which differ greatly in regard to their cause of origin as well as in regard to their clinical course. In spite of that, there is some justification for this generalization since in advanced stages the individual inflammatory diseases involve the entire female pelvis. The following classification may be used:

1. The infection extends by way of the canal superiorly through the vagina, cervical canal, uterus, into the tubes where it leads to a pyosalpinx. In the uterus the inflammation is limited not only to the mucosa but, depending on the protective powers of the body, it extends

to a varied depth into the deeper layers of the uterine musculature.

2. As a result of a rapid extension by way of the lymph paths, there develops an exudate in the parametrium and in the pelvioperitoneum; it is possible that the infection extended through the vagina, cervix, uterus and penetrating the latter reaches the parametrial tissue, or in rare cases the infection may extend from the rectum to the parametrial tissue.

When the inflammatory condition lasts any length of time both paths of infection must pass into each other. When the abdominal end of the tube does not close immediately the infectious agents extend to the peritoneum and there immediately occurs a pelvioperitonitis. Quite frequently with the ascension of the infectious agents and the development of a pyosalpinx the uterine wall is passed through simultaneously and the metritis dissecans complicates the parametritis in the form of a large exudate.

Originally these pelvic affections were treated largely surgically. In the course of years it was found, however, that surgery achieves in these cases only a partial result and as a result of the operative scars the inflammatory process in the pelvioperitoneum and in the parametrium becomes stimulated and extensive adhesions develop. In the course of the last two decades many gynecologists began to influence the conservative method of treatment. The procedure employed by this author is basically as follows. Rest and ice bags are used as long as the process is situated and fever is present. When the fever subsides, heat is employed and gradually intensified. The heat is used in form of sitz baths, hot douches and diathermy. Parallel with the above, proper drug treatment including inner secretory preparations may be used successfully. Since 1924 roentgen treatment has been employed in cases of inflammatory pelvic affections. The roentgen-ray dose employed in these cases must not be of a type which would be destructive to tissue. The dose gnerally employed is approximately 40 per cent skin erythema dose. Best results were obtained by the author from this method of treatment in cases of chronic inflammatory diseases of the pelvis. Doses of the above mentioned type do not lead to castration.

On the basis of the results obtained, Wintz is of the opinion that roentgen irradiation is an important accessory in the treatment of inflammatory pelvic diseases. It has been used by him during the last twenty years and even though some authors have recently expressed the opinion that diathermy is preferable, Wintz does not subscribe to this view. He emphasizes the necessity, however, of strict individualization of the cases.—*A. S. Schwartzman*

SUBJECT INDEX TO VOLUME 42

(abs) = abstract (E) = editorial

Acetabulum, rôle of changes in, in Perthes' disease (abs), 625
Adenocarcinoma of intraoral minor salivary gland, 508
Adenoma, hyperparathyroidism with rather rapid recalcification of bone following removal of (abs), 318
Adrenal glands, rôle of perirenal injections of gas in roentgen study of (abs), 792
Adult, intussusception in, 276
upper lobe pneumonia in (abs), 147
Ainhum, its occurrence in the United States, 246
American Board of Radiology, 137
American Roentgen Ray Society, annual meeting (E), 126; (E), 599
commercial exhibit, 610
new members elected, 1939, 776
officers elected, 1939, 610
program of fortieth annual meeting, 132
scientific exhibit, 605
Amniotic sac, roentgen visualization of, 709
Amputation, spontaneous, of tongue, 843
Anemia, osteosclerotic (abs), 628
Aneurysm, cirsoid, of scalp (abs), 461
dissecting (abs), 617
dissecting, of aorta (abs), 791
of coronary arteries (abs), 463
Angioma in children, radium treatment, 726
Angiosarcoma of bone, 656
Anthracosilicosis, multiple giant bullae associated with, 186
Antirachitic preparation, phosphorus poisoning resulting from (abs), 319
Antrum, carcinoma, life expectancy and incidence of (abs), 475
Aorta, coarctation of (abs), 153; (abs), 617
dissecting aneurysm of (abs), 791
roentgen examination of, 75
Apices, pulmonary, tumors of, and adjacent regions involving brachial plexus (abs), 150
Apparatus, expanding speculum for transvaginal roentgen therapy, 423
for maintaining developing solutions at constant temperature, 141
for measuring quantity of radium, 900
for pneumo-encephalography, 307
for rotational irradiation (abs), 474
for stereoscopic roentgenography of skull, 921
for stereoroentgenoscopy using polarization, 143
universal dosimeter and ultrasensitive electrometer, 428
Artefacts, medullary, in prehistoric bones, 374
Arteries, coronary, aneurysms of (abs), 463
Arteriography, circulatory disturbances in brain resulting from vascular diseases and space occupying lesions as shown by (abs), 787
indications for (abs), 159
use in, of substitutes for colloidal thorium dioxide (abs), 320
Artery, left vertebral, aneurysmal dilatation of (abs), 617
pulmonary, diffuse dilatation of (abs), 154
pulmonary, roentgen examination of, 75
Asbestos body and similar objects in lung (abs), 149
Asbestosis, pulmonary (abs), 149
Asphyxia, local, and roentgen irradiation of transplantable rat tumors, 745
Asthma, relation of heart size to constitutional type in persons with (abs), 463
Atelectasis, "plate-like," of lung (abs), 616
pulmonary, in reference to etiology of bronchiectasis (abs), 464
Atrophy, cerebral, rapidly progressing due to trauma, encephalography in (abs), 146
use of hydrochloric acid in (abs), 159
Axis vertebra, osteoclastoma of (abs), 471

Backache and sciatica, 607
Banti's syndrome with esophageal varices and early hematemesis (abs), 154
Barium enteroclysis, 456
Basilar impression (platybasia) (E), 443
Benzpyrene, production of epithelial tumors by combination of beta radiation and painting with (abs), 480
Beta radiation, production of epithelial tumors by combination of, and painting with benzpyrene (abs), 480
Bile duct, common, pathologic physiology of (abs), 314
Biopsy, aspiration, of tumors in obscure or difficult locations under roentgenoscopic guidance, 515
Bladder, urinary, carcinoma of (abs), 627
urinary, diverticula of (abs), 471
Blood vessels, great, visualization of, in heart disease, 14, 450
Boeck's sarcoid (abs), 628
Bone, angiosarcoma of, 656
correlation between serum phosphatase and roentgenographic type in disease of (abs), 317
hyperparathyroidism with rather rapid recalcification of, following removal of adenoma (abs), 318
Bones, evidences of disturbed prenatal and neonatal growth in, of infants (abs), 158
fractured, use of hydrochloric acid in delayed calcification in (abs), 159
long, tuberculosis of (abs), 158

metastases to, following treatment of uterine carcinoma (abs), 631
multiple cystic tuberculosis of, in children (abs), 157
of growing rats, variations produced in, by parathyroid extract (abs), 478
of skull, reaction of, to intracranial lesions (abs), 462
prehistoric, medullary artefacts in, 374
roentgen appearance of tumors of (abs), 626
signs of fatigue and overwork in (abs), 623
BOOK REVIEWS
The 1938 Year Book of Radiology. Edited by Charles A. Waters, Whitmer B. Firor, and Ira I. Kaplan, 138
Diagrafía: Nuevo metodo radiográfico para el estudio de la órganos móviles. By Guido Pollitzer, 139
A Handbook of Roentgen and Radium Therapy. By A. J. Delario, 139
Pyrétothérapie. By Charles Richet, Jean Surmont, and Pierre Le Gô, 139
A Text-Book of X-Ray Diagnosis. By British Authors. Edited by S. Cochrane Shanks, Peter Kerley, and E. W. Twining, 452
Cancer of the Colon and Rectum: Its Diagnosis and Treatment. By Fred W. Rankin and A. Stephens Graham, 453
Some Fundamental Aspects of the Cancer Problem. Edited by Henry Baldwin Ward, 454
Précis de technique radiographique. By P. Porcher and A. Juquelier, 778
Le duodénum: Atlas de radiologie clinique. By P. Cottenot, Max Lévy, and Ed. Chérigié, 778
Clinical Roentgenology of the Digestive Tract. By Maurice Feldman, 779
Röntgendiagnostik der Gelenke mittels Doppelkontrastmethode. By J. Oberholzer, 779
BOWEN, DAVID RALPH, 1872–1939, obituary (E), 912
portrait, 912
BRACHIAL PLEXUS, tumors of pulmonary apices and adjacent regions involving (abs), 150
BRAIN, circulatory disturbances in, resulting from vascular diseases and space occupying lesions as shown by arteriography (abs), 787
BREAST, cancer, treatment of, by radiation therapy, 389
carcinoma, deep roentgen therapy of, 866
carcinoma, fifteen year observation, 866
carcinoma, further observations, 393
inflammatory carcinoma of (abs), 475
roentgen treatment of primary inoperable carcinoma of, 534
BRONCHIECTASIS, etiology of (abs), 464
in children (abs), 616
BRONCHOGRAPHY, diagnosis of bronchial carcinoma by means of (abs), 615
BROWN-PEARCE RABBIT EPITHELIOMA, lethal effect of roentgen radiation produced by 50 to 1,000 kv. upon, 100
transplant, vascularization of, as seen in transparent ear chamber, 891
BUCCAL CAVITY, cancer, dental lesions observed after roentgen therapy in, 404
cancer, roentgen therapy, 418
BULLAE, multiple giant, associated with anthracosilicosis, 186
BULLETIN of Inter-Society Committee for Radiology, 301, 449, 603, 773, 917

CALCIFICATION, delayed, in fractured bones, use of hydrochloric acid in (abs), 159
of costal cartilages (E), 767
of gastric wall, diagnosis (abs), 620
CALCINOSIS UNIVERSALIS with unusual features (abs), 471
CALCIUM gluconate, remote deposit of calcium salts following injection of (abs), 319
metabolism, effects of treatment on, in human body (abs), 632
metabolism in ossifying fibroma of mandible (abs), 795
salts, remote deposit of, following injection of calcium gluconate (abs), 319
utilizations of (abs), 318
CALCULI, small, effect of, on renal function, 693
urinary, developing in recumbent patients (abs), 470
CALDWELL LECTURE, 1938, 161
CANCER, life expectancy and incidence of (abs), 475; (abs), 477
mammary, treatment of, by radiation therapy, 389
of buccal cavity and cervix uteri, roentgen therapy of, 418
of buccal cavity, pharynx and larynx, dental lesions observed after roentgen therapy in, 404
ovarian, fracture of neck of femur complicating roentgen therapy of, 883
superficial, low voltage lightly filtered roentgen radiation versus radium and high voltage roentgen radiation in treatment of, 556
treatment of, 161
CARCINOMA, and irradiation keratoses, 540
and prepyloric ulcer, 797
bronchial, roentgen diagnosis by bronchography in conjunction with tomography and stereoscopy (abs), 615
inflammatory, of breast (abs), 475
mammary, deep roentgen therapy of, 866
mammary, fifteen year observation, 866
of antrum, life expectancy and incidence of (abs), 475
of breast, further observations, 393
of gastrointestinal tract, life expectancy and incidence of (abs), 477
of hypopharynx producing dysphagia, 173

of larynx, life expectancy and incidence of (abs), 475
of lip, life expectancy and incidence of (abs), 475
of lung, association of silicosis with (abs), 150
of oral cavity, life expectancy and incidence of (abs), 475
of tongue, metastases from, 833
of urinary bladder (abs), 627
primary bronchogenic, 605
primary inoperable, of breast, roentgen treatment, 534
primary, of lung, 606; (abs), 615
primary, of ureter (abs), 315
uterine, osseous metastases following treatment of (abs), 631
Walker rat No. 256, comparison of cytoplasmic changes induced in, by different types and dosages of radiation (abs), 477
Cat, distribution of lead in, after intravenous injection of colloidal lead preparation and effect of irradiation (abs), 480
Cell growth, substances determining, 161
Cerebral atrophy, rapidly progressing due to trauma, encephalography in (abs), 146
pneumography in childhood (abs), 461
ventricles, dilated, explanation for ribbing seen in walls of (E), 769
Chicago Roentgen Society, 136
Childhood, early, factors influencing appearance of centers of ossification during (abs), 794
Children, bronchiectasis in (abs), 616
cerebral pneumography in (abs), 461
crippled, radiological services for, 449
healthy, size of heart in (abs), 152
lipoid pneumonia in (abs), 789
multiple cystic tuberculosis of bones in (abs), 157
radium treatment of angioma in, 726
roentgen therapy of cystic hygroma of neck in, 551
value of special roentgen procedures in detecting cardiac enlargement in, with rheumatic heart disease (abs), 790
young, enlargement of heart in (abs), 463
Cholecystography, floating gallstones an artefact in (abs), 470
medical economics of, 529
reactions following use of pitressin in, 811
Chondrodysplasia (abs), 796
Chondrodystrophy calcificans congenita, 607
Chondro-osteodystrophy (abs), 623
Cineroentgenography, cardiac, 607
Circulation, pulmonary, visualization of, in heart disease, 14, 450
Circulatory disturbances in brain resulting from vascular diseases and space occupying lesions as shown by arteriography (abs), 787
Cirrhosis, malignant lymphogranulomatous, of liver (abs), 159
Clinical symptoms useful as guide for roentgen therapy, 565
Coarctation of aorta (abs), 153; (abs), 617
Coccidioidomycosis (abs), 628
Colitis, ulcerative, 608
Colon, roentgen examinations in tropical diseases of (abs), 792
Condyle, lateral, of humerus, regeneration of, after excision (abs), 795
Congenital cardiovascular disease, roentgenology of, 72
ciliated columnar epithelial cysts of mediastinum (abs), 148
defect of femur with malformations of pelvis and hand (abs), 624
pseudoarthrosis of tibia, 104
Coronary arteries, aneurysms of (abs), 463
Costal cartilages, calcification of (E), 767
Crohn's disease (abs), 468
Cushing, Harvey, biography of, 777
Cysts, calcified hydatid (abs), 160
congenital ciliated columnar epithelial, of mediastinum (abs), 148
Cytoplasm, changes of, induced in Walker rat carcinoma No. 256 by different types and dosages of radiation (abs), 477

Deglutition, roentgen examination of (abs), 614
Dental lesions observed after roentgen therapy in cancer of buccal cavity, pharynx and larynx, 404
Developing solutions, device for maintaining solutions at constant temperature, 141
Diaphragm, hernia of, in newborn (abs), 154
Dilatation, aneurysmal, of left vertebral artery (abs), 617
diffuse, of pulmonary artery (abs), 154
Diodrast, excretory urography by intramuscular injection of (abs), 793
for use in arteriography (abs), 320
for visualization of chambers of heart, pulmonary circulation, and great blood vessels in heart disease, 14
Directory of medical specialists, 919
Diverticula, inflammatory, of heart, 38
true and false, of duodenum, differential diagnosis (abs), 155
vesical, 53 cases of (abs), 471
Diverticulum, Meckel's, roentgen diagnosis, 280
of duodenum (abs), 468
Dosage delivered by radiation therapy, calculations of, in mammary cancer, 389
depth, effect of heavy filtration on, 756
method of obtaining greater ratio of deep to surface, 760
small, in radiation treatment of functional gynecological conditions, 731
Dosimeter, universal, and ultrasensitive tube electrometer, 428
Drosophila melanogaster, comparative effect of 200

kv. roentgen rays and gamma rays on pupae of (abs), 479
Duodenum, diverticulum of (abs), 468
perforation of, in newborn (abs), 792
true and false diverticula of, differential diagnosis (abs), 155
Dyschondroplasia of distal radial epiphysis, 671
Dysphagia, diseases of hypopharyngeal region producing, 173

Ear chamber, transparent, vascularization of Brown-Pearce rabbit epithelioma as seen in, 891
Editorials
The annual meeting, 126
Byron Hubbard Jackson, 1873–1939, 127
Essentials of a registered hospital, 291
Henry Khunrath Pancoast, 1875–1939, 293
Charles de Forest Lucas, 1899–1939, 297
Basilar impression (platybasia), 443
Lester I. Levyn, 1886–1938, 445
The annual meeting, 599
Calcification of the costal cartilages, 767
Explanation for the ribbing seen in walls of dilated cerebral ventricles, 769
The radiotherapeutic aspect of malignant tumors of the thyroid gland, 909
David Ralph Bowen, 1872–1939, 912
Effect, biological, of roentgen rays (abs), 634
comparative, of 200 kv. roentgen rays and gamma rays on pupae of *Drosophila melanogaster* (abs), 479
of heavy filtration on skin tolerance and depth dose, 756
of irradiation on distribution of lead in cat after intravenous injection of colloidal lead preparation (abs), 480
of radiation therapy on gastric secretion (abs), 630
of roentgen rays on inflammatory processes, mechanism of (abs), 934
of roentgen rays on nucleated and non-nucleated egg fragments (abs), 479
of treatment on radium and calcium metabolism in human body (abs), 632
physiological, of radiation, 110
Egg fragments, nucleated and non-nucleated, action of roentgen rays on (abs), 479
Electrical protective device in radium work, 930
Electrometer, ultrasensitive tube, and universal dosimeter, 428
Emphysema, spontaneous mediastinal (abs), 789
Encephalitis, roentgen treatment, 561
Encephalography in rapidly progressing cerebral atrophy due to trauma (abs), 146
intracranial conditions in childhood identified by (abs), 461
Endocrine influences, sensitivity of skin to roentgen radiation and its relation to (abs), 633
Endothelioma, vascular, of lung (abs), 466
Enteroclysis, barium, 456
Epiphyseolysis, etiology of (abs), 157
Epiphyses, hereditary multiple disturbances of ossification of, as clinical entity (abs), 624
persistent vertebral process, 85
Epiphysis, distal radial, dyschondroplasia of, 671
Epithelioma, Brown-Pearce rabbit, lethal effect of roentgen radiation produced by 50 to 1,000 kv. upon, 110
transplant, Brown-Pearce rabbit, vascularization of, as seen in transparent ear chamber, 891
Esophageal varices, effect of splenectomy and ligation of gastric coronary vessels, in case of Banti's syndrome with early hematemesis (abs), 154
Esophagitis, stenosing, associated with duodenal ulcer, 724
Esophagus, dilatations of, 173
mucosal pattern technique and kymographic records of (abs), 466
stenosis of, 173
ulcers of (abs), 147
Ewing's sarcoma (abs), 626
sarcoma, diagnosis, differential diagnosis and therapy (abs), 794
tumor (abs), 320
Exostoses, hereditary multiple cartilaginous (abs), 796
Eye, early detection of intraocular foreign body of metallic density, 436

Femur, aseptic necrosis of head of, following traumatic dislocation (abs), 625
congenital defect of (abs), 624
fracture of neck of, complicating roentgen therapy of ovarian cancer, 883
Fibrin bodies, 532
Fibroma, ossifying, of mandible, calcium and phosphorus metabolism in (abs), 795
Fibula, osteochondroma of, with resultant foot drop (abs), 795
Filtration, heavy, effect of, on skin tolerance and depth dose, 756
relation between tin and copper, when using a thick-walled roentgen tube, 122
Fistulae, bronchial and esophageal (abs), 619
Foot drop, result of osteochondroma of fibula (abs), 795
Foreign bodies in upper alimentary canal causing dysphagia, 173
Foreign body, intraocular, of metallic density, early detection of, 436
Fracture of femoral neck complicating roentgen therapy of ovarian cancer, 883
Fractures of sacrum, their incidence in fracture of pelvis, 100
vertebral, involvement of intervertebral disc in, 235

Gallstones, floating, cholecystographic artefact (abs), 470
gas-containing (abs), 469
preoperative roentgen diagnosis of ileus due to (abs), 469
Gamma rays, comparative effect of, and 200 kv. roentgen rays on pupae of *Drosophila melanogaster* (abs), 479
Gas, perirenal injections of, in roentgen study of adrenal glands (abs), 792
Gastric secretion, effect of radiation therapy on (abs), 630
Gastritis, follicular, report of case, 438
Gastrointestinal tract, carcinoma, life expectancy and incidence of (abs), 477
disturbances of rotation of (abs), 621
symptomless perforation of (abs), 155
use of intestinal intubation in localization of lesions of, 321
Genital organs, female, conservative treatment of inflammations of, by aid of roentgen rays (abs), 935
Gliomas, effect of roentgen therapy on (abs), 471
Golgi apparatus in estimation of cytoplasmic changes from different types and dosages of radiation (abs), 477
Gynecological conditions, functional, irradiation with small doses in treatment of, 731

Hand, malformations of (abs), 624
Hand-Schüller-Christian's disease (abs), 624
Heart, and sport (abs), 790
compression of, due to pericardial scar, 38
determination of area of, 611
determination of size of, 1
disease, acquired valvular, roentgen aspects, 47
disease, arteriosclerotic, value of contrast roentgenograms of heart in, 14
disease, congenital, roentgenology of, 72
disease, hypertensive, value of contrast roentgenograms of heart in, 14
disease, non-valvular, roentgen aspects, 60
disease, rheumatic—mitral stenosis, value of visualization of chambers of heart in, 14
disease, rheumatic, special roentgen procedures in detecting cardiac enlargement in children with (abs), 790
disease, visualization of chambers of heart, pulmonary circulation and great blood vessels in, 14, 450
enlargement of, in infants and young children (abs), 463
inflammatory diverticula of, 38
kymography of (abs), 618
measurement of, aided by horizontal orthodiagraphy, 264
normal volume of, in man (abs), 152
present day attitude to estimation of size of, and to question of damage (abs), 790
roentgen estimation of size of (abs), 618; (abs), 619
roentgen kymographic examination of function of (abs), 153
roentgen observations in congestion of (abs), 791
roentgen study of function of (abs), 465
roentgen tests of function of (abs), 791
size of, and asthma constitution (abs), 463
size of, in healthy children (abs), 152
special roentgen procedures in detecting enlargement of, in children with rheumatic heart disease (abs), 790
visualization of chambers of, in heart disease, 14
Hemangioma of vertebra with compression myelopathy, 192
Hematoma of kidney bed, roentgen picture (abs), 621
Hernia, diaphragmatic, in newborn (abs), 154
Hodgkin's disease, 608
of liver (abs), 159
radium therapy in, 888
with ulcerative involvement of skin (abs), 148
Hospital, essentials of a registered (E), 291, 301
Humerus, regeneration of lateral condyle of, after excision (abs), 795
Hydatid cysts, calcified (abs), 160
Hydrochloric acid, use of, in atrophy and delayed calcification in fractured bones (abs), 159
Hygroma, cystic, of neck in children, roentgen therapy, 551
Hyperparathyroidism simulating or associated with Paget's disease (abs), 319
with rather rapid recalcification of bone following removal of adenoma (abs), 318
Hyperthyroidism, non-operative treatment of (abs), 631
Hypopharyngeal region, diseases of, producing dysphagia, 173

Ileitis, regional (abs), 468
Ileus, gallstone, preoperative roentgen diagnosis (abs), 469
Indiana Roentgen Society, 136
Indians, pre-Columbian, medullary artefacts in bones of, 374
Indigestion, diagnosis of functional (abs), 620
Infancy, early, syphilis of skeleton in, 637
Infant, phosphorus poisoning in, resulting from an antirachitic preparation (abs), 319
Infants, anterior and posterior "notch" shadows seen in lateral roentgenograms of vertebrae of, 663
disturbed prenatal and neonatal growth in bones of (abs), 158
enlargement of heart in (abs), 463
lipoid pneumonia in (abs), 789
newborn, tetany syndrome in (abs), 319
Infection in otolaryngology, irradiation for (abs), 472

prevention and treatment of, by mobile x-ray unit, 608
INFLAMMATIONS, fundamentals of roentgen therapy of (abs), 934
mechanism of action of roentgen rays on (abs), 934
metastatic pulmonary infiltrations from, 828
of female genital organs, conservative treatment of, by aid of roentgen rays (abs), 935
INFLAMMATORY carcinoma of breast (abs), 475
diseases of pericardium, 38
processes producing dysphagia, 173
INJURIES, radiation, in roentgen diagnosis, avoidance of (abs), 474
INNOMINATE BONE, plasmocytoma of (abs), 622
INSTITUTE for consideration of blood and blood-forming organs, 135
INTERVERTEBRAL DISC, experimental studies on, 235
function of, 235
involvement of, in vertebral fractures and in spinal pathology, 235
roentgenologic diagnosis of intraspinal protrusion of, 608
INTESTINAL intubation, use of, in localization of lesions of gastrointestinal tract, 321
INTESTINE, large, rapid functional test of (abs), 156
small, method for direct immediate examination of, by single and double contrast techniques, 456
INTRACRANIAL LESIONS, reaction of bones of skull to (abs), 462
INTRALARYNGEAL FILMS, examination of larynx and adjacent structures with, 481
INTRATHORACIC LESIONS, density of central shadow in diagnosis of (abs), 789
INTUSSUSCEPTION in adult, 276
IODINE SOLS, roentgen visualization of liver and spleen with (abs), 469
IRRADIATION keratoses and carcinoma, 540
protracted external, in neoplasms of upper respiratory tract, 572

JACKSON, BYRON HUBBARD, 1873–1939, obituary (E), 127
portrait, 127
JENKINSON, EDWARD L., portrait opposite page 481

KERATOSES, irradiation, and carcinoma, 540
KIDNEYS, effect of small stones on function of, 693
roentgen diagnosis of infection of, 689
roentgen picture of hematoma of (abs), 621
tuberculosis, pathogenesis and roentgen findings, 700
KYMOGRAPHY in diagnosis of conditions of stomach and esophagus (abs), 466
of heart (abs), 618
roentgen, determinations of cardiac size and output by, 606
roentgen, examination of cardiac function by (abs), 153
studies on competitive athletes by (abs), 790
value of, in diagnosis of pericardial effusions, 38
KYPHOSIS, progressive, from congenital wedge-shaped vertebrae (abs), 623

LAMINECTOMY in Paget's disease of vertebral column, 345
LARYNX, cancer, dental lesions observed after roentgen therapy in, 404
carcinoma, life expectancy and incidence of (abs), 475
examination of, and adjacent structures with intralaryngeal films, 481
physiological movements of, 173
roentgen examination of (abs), 614
LEAD, distribution of, in cat, after intravenous injection of colloidal lead preparation, and effect of irradiation (abs), 480
poisoning (abs), 478
LEG, unilateral enlargement of, accompanying varicose veins, 683
LEVYN, LESTER I., 1886–1938, obituary (E), 445
portrait, 445
LIFE expectancy and incidence of malignant disease (abs), 475; (abs), 477
LIP, carcinoma, life expectancy and incidence of (abs), 475
LIPOID pneumonia in infants and children (abs), 789
LIPIODOL, removal of, after myelography, 525
LIPOSARCOMA, of mediastinum and lung, 341
LIVER, malignant lymphogranulomatous cirrhosis of (abs), 159
roentgen visualization of, with iodine sols (abs), 469
LONG ISLAND RADIOLOGICAL SOCIETY, 136
LUCAS, CHARLES DE FOREST, 1899–1939, obituary (E), 297
portrait, 297
resolutions presented by American Radium Society on death of, 298
LUNG, roentgen measurements of apico-basal relaxation of, during artificial pneumoperitoneum treatment (abs), 151
vascular endothelioma of (abs), 466
LUNGS, asbestos body and similar objects in (abs), 149
association of silicosis and carcinoma of (abs), 150
liposarcoma of, 341
lymphosarcoma of, 503
metastatic infiltrations of, of inflammatory origin, 828
non-putrid suppuration of, 606
"plate-like" atelectasis of (abs), 616
primary carcinoma of (abs), 615
roentgen observations in cardiac congestion of (abs), 790
tumors of apices of, and adjacent regions involving brachial plexus (abs), 150
LYMPH GLANDS, anthracotic, sequestration of, at

tracheal bifurcation with bronchial and esophageal fistulae as clinical entity (abs), 619
Lymphadenoma, regional x-ray baths in treatment of (abs), 630
Lymphatic block, enlargement of lower extremity as result of, 683
Lymphoblastoma, 608
Lymphogranuloma venerum, roentgen therapy in, 376
Lymphosarcoma, 608
of stomach, diagnosis and treatment, 332
pulmonary, 503

McFarland, Joseph, portrait opposite page 161
Madelung's deformity, roentgen diagnostic criteria, 671
Mandible, calcium and phosphorus metabolism in ossifying fibroma of (abs), 795
Marble bone disease, roentgen appearance at autopsy (abs), 624
Measurements, radiometric, of skin response to actinic radiation, 609
roentgen, of apico-basal relaxation of lung during artificial pneumoperitoneum treatment (abs), 151
roentgen, of cardiac area and transverse diameter in 67 children between birth and age of six years (abs), 152
Meckel's diverticulum, roentgen diagnosis, 280
Mediastinitis, acute and chronic (abs), 619
Mediastinum, congenital ciliated columnar epithelial cysts of (abs), 148
liposarcoma of, 341
Medical specialists, directory of, 919
Medullary artefacts in prehistoric bones, 374
Meningiomas, anterior basal (abs), 460
Metabolism, calcium and phosphorus, in ossifying fibroma of mandible (abs), 795
calcium, effects of treatment on, in human body (abs), 632
Metastases, cancer, differentiation from angiosarcoma of bone, 656
from carcinoma of tongue, 833
osseous, following treatment of uterine carcinoma (abs), 631
pulmonary, of inflammatory origin, 828
Mitochondria of tumor cells in estimation of cytoplasmic changes from different types and dosages of radiation (abs), 477
Mitral valve, typical auricular pulsation in insufficiency of (abs), 618
Morquio's disease (abs), 623
Mucosal pattern technique and kymographic records of esophagus and stomach (abs), 466
Myelography, removal of lipiodol after, 525
Myeloma, multiple, differentiation from angiosarcoma of bone, 656
Myelopathy, compression, in hemangioma of vertebra, 192
Myography, roentgen (abs), 478

Nasophyarynx, malignant neoplasms of (abs), 146
Neck, cystic hygroma of, in children, roentgen therapy, 551
Necrosis, aseptic, of head of femur following traumatic dislocation (abs), 625
Neoplasia, reticulo-endothelial, 820
Neoplasms, malignant, of nasopharynx (abs), 146
Neurofibromatosis with malignant thoracic tumor and metastasis in child (abs), 793
Neurological study, significance of roentgen examination of deglutition in (abs), 614
Neuropathic disorders causing dysphagia, 173
Nevi, vascular, roentgen therapy, 609
New York Roentgen Society, 136
Newborn, diaphragmatic hernia in (abs), 154
duodenal perforation in (abs), 792
spontaneous pneumothorax in (abs), 788
tension pneumothorax in (abs), 151
Nobel Prize in physics, 919
"Notch" shadows, anterior and posterior, seen in lateral roentgenograms of vertebrae of infants, 663
Nucleus pulposus, roentgen diagnosis of injuries of, 235
rupture of (abs), 626

Oral cavity, carcinoma, life expectancy and incidence of (abs), 475
Orthodiagraphy, horizontal, cardiac mensuration aided by, 264
Ossification, epiphyseal, hereditary multiple disturbances of, as clinical entity (abs), 624
factors influencing appearances of centers of, during early childhood (abs), 794
Osteitis deformans of vertebrae, compression of spinal cord in, 345
Osteochondritis, syphilitic, lesions simulating, found in non-syphilitic infants, 637
Osteochondroma of fibula with resultant foot drop (abs), 795
Osteochondrosis deformans tibiae, 498
Osteoclastoma of axis vertebra (abs), 471
Osteomyelitis, acute infective, of spine (abs), 622
syphilitic, diagnostic features, 637
Osteoperiostitis, syphilitic-like, in non-syphilitic infants, 637
Osteosarcoma of bony pelvis (abs), 627
Osteosclerosis associated with anemia (abs), 628
Otitis media, acute and chronic, roentgen therapy in, 285, 451
Otolaryngology, irradiation for infection in (abs), 472
Ottonello's method, roentgenography of second cervical vertebra by (abs), 478
Ovary, cancer, fracture of neck of femur complicating roentgen therapy of, 883

Pacific Roentgen Club, 136

PAGET'S DISEASE, hyperparathyroidism simulating or associated with (abs), 319
of vertebrae, compression of spinal cord in, 345
PANCOAST, HENRY KHUNRATH, 1875–1939, obituary (E), 293
portrait, 293
PARATHYROID extracts, variations produced in bones of growing rats by (abs), 478
glands, depletion of storage of calcium by activities of (abs), 318
PATIENTS, with cancer, study of, 161
PELVIMETER, Torpin-Thoms roentgen, 608
PELVIMETRY, roentgen, simplified method, 847
PELVIS, bony, osteosarcoma of (abs), 627
incidence of fractures of sacrum in fracture of, 100
malformations of (abs), 624
PENIS, plastic induration of, radium treatment, 545
PEPTIC ULCER, duodenal, associated with stenosing esophagitis, 724
prepyloric, and carcinoma, 797
roentgen evidence of healing in (abs), 467
PERFORATION, symptomless, of gastrointestinal tract (abs), 155
PERICARDITIS, tuberculous, clinically manifest (abs), 789
PERICARDIUM, inflammatory diseases of, 38
PERTHES' DISEASE, rôle of acetabular changes in (abs), 625
PETROUS tip suppuration, observations on (abs), 461
PEYRONIE'S DISEASE, radium treatment, 545
PHALANGES, terminal, developmental abbreviation of (abs), 622
PHARYNX, cancer, dental lesions observed after roentgen therapy in, 404
physiological movements of, 173
PHOSPHATASE, serum, correlation between and roentgenographic type in bone disease (abs), 317
PHOSPHORUS metabolism in ossifying fibroma of mandible (abs), 795
poisoning in an infant resulting from antirachitic preparation (abs), 319
PHOTOGRAPHY, miniature clinical, 609
roentgen, two years of (abs), 633
PHYSICS, Nobel prize in, 919
PICK'S SYNDROME, 38
PINEAL GLAND, methods for determining position of, 490
shadow, determination and diagnostic evaluation of displacement of, in lateral roentgenogram (abs), 787
PITRESSIN, reactions following use of, in cholecystography, 811
PITTSBURGH ROENTGEN SOCIETY, 137
PLACENTA, localization of, 608
previa, roentgen diagnosis of, 709
roentgen visualization of, 709
PLASMOCYTOMA of innominate bone (abs), 622
PLATYBASIA (E), 443
PLEXUS, brachial, tumors of pulmonary apices and adjacent regions involving (abs), 150
PNEUMATOCELE capitis (abs), 460
PNEUMOCONIOSIS, roentgen-ray diffraction analysis as applied in (abs), 634
PNEUMO-ENCEPHALOGRAPHY, 605
apparatus for, 307
PNEUMOGRAPHY, cerebral, in childhood (abs), 461
PNEUMONIA, lipoid, in infants and children (abs), 789
lobar, roentgen treatment, 411
upper lobe, in adult (abs), 147
PNEUMOPERITONEUM treatment, artificial, roentgen measurements of apico-basal relaxation of lung during (abs), 151
PNEUMOTHORAX, artificial, contralateral spontaneous pneumothorax complicating (abs), 151
contralateral spontaneous, complicating artificial pneumothorax (abs), 151
spontaneous, associated with spontaneous mediastinal emphysema (abs), 789
spontaneous, in newborn (abs), 788
spontaneous, types of (abs), 788
tension, in newborn (abs), 151
POLARIZATION, stereoroentgenoscopy using, 143
POLYHYDRAMNIOS, roentgen diagnosis of, 709
PREGNANCY, extra-uterine, roentgen diagnosis of, 709
roentgen visualization of soft tissues in, 709, 718
PROSTATE, rhabdomyosarcoma of (abs), 316
PROTECTION, electrical devices for, in work with radium, 930
roentgen-ray and radium, 609
PSEUDARTHROSIS, congenital, of tibia, 104
PULMONARY ARTERY, diffuse dilatation of (abs), 154
roentgen examination of, 75
PURPURA HEMORRHAGICA, splenic irradiation in treatment of (abs), 632

RADIATION, actinic, radiometric measurement of skin response to, 609
comparison of cytoplasmic changes induced in Walker rat carcinoma 256 by different types and dosages of (abs), 477
damages in roentgen diagnosis and their avoidance (abs), 474
effects, rhythm of, 572
physiological effects of, 110
therapy, effect of, on gastric secretion (abs), 630
RADIOLOGICAL Conference, mid-summer, in Rocky Mountains, 135
practice, business side of, 603, 773
services for crippled children, 449
Society of New Jersey, 136
RADIOLOGISTS, Midwinter Conference of Eastern, 903, 920
postgraduate courses for, 305
RADIOLOGY, actions pertaining to, at St. Louis session of American Medical Association, 301

Radiosensitivity of tonsils, new method to raise (abs), 473
Radium, effects of treatment on, in human body (abs), 632
electrical protective devices for work with, 930
experiments on production of spinal deformities by, 217
protection, 609
quantity meter, 900
resolution on prescribing of, 302
therapy in Hodgkin's disease, 888
treatment of angioma in children, 726
treatment of Peyronie's disease, 545
Rats, growing, variations produced in bones of, by parathyroid extracts (abs), 478
Rectum, stenosis of, from roentgen therapy (abs), 632
Respiratory tract, upper, protracted external irradiation of neoplasms of, 572
Reticulo-endothelial neoplasia, 820
Rhabdomyosarcoma of prostate (abs), 316
Rhythm of radiation effects, 572
Rickets, phosphorus poisoning in infant resulting from preparation against (abs), 319
Riedel's thyroiditis, radium treatment (abs), 629
Roentgen diagnosis, radiation damages in, and their avoidance (abs), 474
examination of paranasal sinuses, value of (abs), 788
films, intralaryngeal, examination of larynx and adjacent structures with, 481
irradiation, effect of, on distribution of lead in cat after intravenous injection of colloidal lead preparation (abs), 480
irradiation, regional body, in treatment of lymphadenoma (abs), 630
irradiation, rotational (abs), 474
irradiation with small doses in functional gynecological conditions, 731
myography (abs), 478
photography, two years of (abs), 633
radiation, lethal effect of, produced by 50 to 1,000 kv. on Brown-Pearce rabbit epithelioma, 110
-ray diffraction analysis as applied in pneumoconiosis (abs), 634
-ray protection, 609
rays, action of, on nucleated and non-nucleated egg fragments (abs), 479
rays, beginning use of, 161
rays, biological action of (abs), 634
rays, 200 kv., comparative effect of, and gamma rays on pupae of *Drosophila melanogaster* (abs), 479
therapy, clinical symptoms useful as guide for, 565
therapy of cystic hygroma of neck in children, 551
treatment of encephalitis, 561
tube, thick-walled, relation between tin and copper filtration when using, 122
Roentgenogram, pathology of base of skull in (abs), 787
Roentgenograms, lateral, of vertebrae of infants, anterior and posterior "notch" shadows seen in, 663
Roentgenographic changes, nonspecificity of many, of syphilis of skeleton in early infancy, 637
Roentgenography, stereoscopic, of skull, apparatus for, 921
Roentgenology, neurologic, course in, 636
Roentgenoscopy, aspiration biopsy of tumors in obscure or difficult locations under, 515

Sacrum, fractures of, incidence in fracture of pelvis, 100
Salivary gland, intraoral minor, adenocarcinoma, 508
Salpinx, histological and roentgen study of interstitial portion of (abs), 792
Sarcoid, Boeck's (abs), 628
Sarcoma, Ewing's (abs), 626
Ewing's, diagnosis, differential diagnosis and therapy (abs), 794
osteogenic, differentiation from angiosarcoma of bone, 656
primary, of vertebra, differential diagnosis (abs), 625
Scalp, cirsoid aneurysm of (abs), 461
Schmitz, Henry, resolutions presented by American Radium Society on death of, 305
Sciatica and backache, 607
Science, keeping in step with (Caldwell Lecture, 1938), 161
Scoliosis, experimental production of, by radium, 217
Sensitivity of skin to roentgen radiation and its relation to endocrine influences (abs), 633
Sigmoid, roentgen visualization of deep-seated pathologic processes in (abs), 156
Silicosis, association of, and carcinoma of lung (abs), 150
hematogenous tuberculosis and (abs), 465
study of (abs), 149
Silvanus Thompson Memorial Lecture, 20th (abs), 634
Sinuses, paranasal, value of roentgen examination of (abs), 788
roentgen treatment of infections of, 857
Skeleton, syphilis of, in early infancy, 637
Skin response to actinic radiation, radiometric measurement of, 609
sensitivity of, to roentgen radiation, and its relation to endocrine influences (abs), 633
tolerance, effect of heavy filtration on, 756
ulcerative involvement of, in Hodgkin's disease (abs), 148

SKULL, air under pericranium of one or several bones of (abs), 460
apparatus for stereoscopic roentgenography of, 921
normal, anomalies and variations from roentgen viewpoint, 367
pathology of base of, in roentgenogram (abs), 787
reaction of bones of, to intracranial lesions (abs), 462
SOFT TISSUES, roentgen visualization of, in pregnancy, 709, 718
SOLOMON MEMORIAL LIBRARY, 306
SPECULUM, expanding, for transvaginal roentgen therapy, 423
SPINAL CORD, compression of, in osteitis deformans of vertebrae, 345
SPINE, acute infective osteomyelitis of (abs), 622
compression fractures of, differential diagnosis, 607
experiments on production of deformities of, by radium, 217
involvement of intervertebral disc in pathology of, 235
motion in, 91
movements of, 235
SPLEEN, irradiation of, in treatment of purpura hemorrhagica (abs), 632
roentgen visualization of, with iodine sols (abs), 469
SPLENECTOMY and ligation of gastric coronary vessels (abs), 154
STENOSIS, rectal, from roentgen therapy (abs), 632
STEREOROENTGENOSCOPY using polarization, 143
STEREOSCOPY, diagnosis of bronchial carcinoma by means of (abs), 615
STOMACH, benign tumors, differential diagnosis (abs), 467
diagnosis of calcification of wall of (abs), 620
lymphosarcoma of, diagnosis and treatment, 332
mucosal pattern technique and kymographic records of (abs), 466
SULCUS, superior, tumors of (abs), 465
SUPPURATION, petrous tip (abs), 461
SYMPUS MONOPUS, 721
SYPHILIS, infantile, nonspecificity of skeletal changes in, 607
of skeleton in early infancy, 637
SYPHILITIC cardiovascular disease, value of contrast roentgenograms of heart in, 14

TECHNIQUE for determination of cardiac area, 611
of aspiration biopsy, 515
perirenal injections of gas in roentgen study of adrenal glands (abs), 792
rapid functional test of large intestine (abs), 156
roentgenographic method for study of second cervical vertebra, 782
roentgenography of second cervical vertebra by Ottonello's method (abs), 478
single and double contrast, method for direct immediate examination of small intestine, 456
TETANY syndrome in newborn infants (abs), 319
THORACIC VISCERA, 607
THORIUM DIOXIDE, colloidal, use in arteriography of substitutes for (abs), 320
THROMBOSIS, deep venous, enlargement of lower extremity due to, 683
THUMBS, three-phalangeal, 677
THYROID GLAND, radiotherapeutic aspect of malignant tumors of (E), 909
THYROIDITIS, Riedel's, radium treatment (abs), 629
TIBIA, congenital pseudarthrosis of, 104
TISSUES, soft, roentgen visualization of, in pregnancy, 709, 718
TOMOGRAPHY, diagnosis of bronchial carcinoma by means of (abs), 615
TONGUE, lymphatic drainage of, 833
malignant tumors of, modified method of treatment, 890
metastases from carcinoma of, 833
spontaneous amputation of, 843
TONSILS, new method to raise radiosensitivity of (abs), 473
TRAUMA, rapidly progressing cerebral atrophy due to, encephalography in (abs), 146
TROPICAL diseases of colon, roentgen examinations in (abs), 792
TUBERCULOSIS, hematogenous, and silicosis (abs), 465
multiple cystic, of bones in children (abs), 157
of long bones (abs), 158
of pericardium (abs), 789
renal, pathogenesis and roentgen findings, 700
TUMOR, Ewing's (abs), 320
malignant thoracic and metastasis in child, with neurofibromatosis (abs), 793
TUMORS, aspiration biopsy of, in obscure or difficult locations under roentgenoscopic guidance, 515
benign gastric, differential diagnosis (abs), 467
bone, roentgen appearance of (abs), 626
epithelial, production of, by combination of beta radiation and painting with benzpyrene (abs), 480
malignant, of thyroid gland, radiotherapeutic aspect (E), 909
malignant, of tongue, modified method of treatment, 890
of pulmonary apices and adjacent regions involving brachial plexus (abs), 150
of superior sulcus (abs), 465
of upper respiratory tract, protracted external irradiation of, 572
reticulo-endothelial, 820
transplantable rat, local asphyxia and roentgen irradiation of, 745

Ulcerative involvement of skin in Hodgkin's disease (abs), 148
Ulcers, esophageal (abs), 147
Ureter, primary carcinoma of (abs), 315
Ureteral obstruction, 608
Urethrography, 608
Urinary calculi developing in recumbent patients (abs), 470
Urography, excretory, by intramuscular injection of diodrast (abs), 793
in diagnosis of renal infection, 689
Uterus, carcinoma, osseous metastases following treatment of (abs), 631
cervix, cancer, expanding speculum for transvaginal roentgen therapy, 423
cervix, cancer, roentgen therapy of, 418

Vascular diseases, circulatory disturbances in brain resulting from, shown by arteriography (abs), 787
Vascularization of Brown-Pearce rabbit epithelioma transplant as seen in transparent ear chamber, 891
Veins, varicose, unilateral enlargement of lower extremity accompanying, 683
Venography in unilateral enlargement of lower extremity, 683
Venous block, deep, roentgen studies of, 683
Ventriculography, intracranial, conditions in childhood identified by (abs), 461
Vertebra, hemangioma of, with compression myelopathy, 192
persistent epiphyses of processes of, 85
primary sarcoma of, differential diagnosis (abs), 625
second cervical, roentgenographic method for study of, 782
second cervical, roentgenography of, by Ottonello's method (abs), 478
Vertebrae, compression of spinal cord in osteitis deformans of, 345
congenital wedge-shaped, progressive kyphosis from (abs), 623
involvement of intervertebral disc in fractures of, 235
of infants, anterior and posterior "notch" shadows seen in lateral roentgenograms of, 663

Walker rat carcinoma 256, comparison of cytoplasmic changes induced in, by different types and dosages of radiation (abs), 477
Wilson's procedure in recognizing early cardiac enlargement (abs), 790
Wrist, Madelung's deformity, 671

Xanthomatosis (abs), 624
of bone, differentiation from angiosarcoma, 656
Xanthomatous diseases, different clinical groups of (abs), 316

AUTHOR INDEX TO VOLUME 42

Abbott, W. Osler, 330
Abel, Walter, 620
de Abreu, Manoel, 633
Ackermann, Alfred J., 828
Addington, E. A., 608
Aguirre, Juan Alberto, 455
Allebach, H. K., 793
Allen, Frederick M., 745
Amtman, Jennie K., 154
Andosca, John B., 151
Anton, Joseph I., 671
Appelbaum, Emanuel, 153
Archer, Vincent W., 332, 340
Aub, J. C., 632

Bachman, Arnold, 147
Bade, Heinz, 794
Bailey, Wilbur, 85
Baker, Norman H., 891
Baker, S. L., 471
Banyai, Andrew L., 151
Barber, C. Glenn, 498
Barrington-Ward, Lancelot, 468
Bartels, W. P., 607
Batts, Martin, Jr., 626
Bauer, John T., 605
Bauer, R., 614
Beckermann, Franz, 469
Beckstrand, Grant, 389, 403
Bell, Joseph C., 307
Berger, R. A., 551
Bernheim, Alice R., 159
Biegeleisen, H. I., 683
Bierce, George E., 141
Biller, S. B., 883
Bird, Clarence E., 320
Bishop, Paul A., 141, 605, 914
Blady, John V., 515, 524
Bloxsom, Allan, 471
Bohrod, Milton G., 374
Boone, W. H., 608
Bowen, J. Andrew, 693
Bowers, Ralph F., 341, 343
Boyd, Linn J., 617
Breimer, Charles W., 607
Brennecke, Frances, 795
Briesen, H. V., 525
Brodney, M. L., 608
Bromer, Ralph S., 670, 789
Bromley, J. F., 622
Brown, J. P., 285, 451
Brown, Percy, 129, 296
Brown, Webster H., 608
Brownell, Durwin H., 146
Bucky, Gustav, 428
Bürger, M., 791
Burrows, H. Jackson, 622
Burrows, Robert B., 478
Butsch, Winfield L., 314

Caffey, John, 607, 637
Camp, John D., 608
Campbell, Don M., 436
Carty, John R., 717
Charr, Robert, 186
Charteris, Alexander A., 629
Chérigié, Ed., 778
Childe, A. E., 461, 496
Clarkson, Wright, 339
Cohen, Henry, 316
Cohen, Louis, 465
Cooper, George, Jr., 332
Cornell, Nelson W., 159
Cottenot, P., 778
Cowan, Leland R., 556
Craver, Lloyd F., 344
Crawford, B. L., 480
de Crinis, M., 787
Crowther, J. A., 634
Curtis, George M., 795

Dahm, Max, 465
Dannenberg, Max, 671
Davidson, M., 464
Decker, Fred H., 374
Delario, A. J., 139
de Lorimier, Alfred A., 376
del Regato, J. A., 404
De Ment, Jack, 930
Dennig, Helmut, 631
Denzer, Bernard S., 154
Desjardins, Arthur U., 534, 609
Dickson, Ernest C., 628
Diethelm, L., 467
Dimtza, A., 159
Dippel, A. L., 608
Dörr, Hans, 631
Donovan, Edward J., 621
Dowell, D. Arnold, 608
Drenckhahn, C. H., 792
Dresser, Richard, 110, 756
Dreyer, Werner, 615
Duffy, James J., 540
Dyke, Cornelius G., 497, 605

Edwards, A. Tudor, 466
Ehrenpreis, Bernard, 280
Ehrlich, David E., 788
Ellinger, Erika, 463
Elward, Joseph F., 91, 903
Engel, D., 217
Erdelyi, J., 473
Ernst, Edwin C., 881
Erskine, Arthur W., 423
Ettinger, Alice, 616
Evans, R. D., 632
Evans, William A., 866

Failla, G., 538, 764, 902
Fariñas, Pedro L., 606
Feldman, Maurice, 779
Ferrier, Paul A., 315
Firor, Whitmer B., 138, 857, 865
Fogg, Lloyd C., 477
Foord, Alvin G., 315
Fowweather, F. A., 470
Francis, Carl C., 794
Fray, Walter W., 490
Freedman, Eugene, 38, 83
Freund, Franz, 934
Fricke, Robert E., 545, 550, 555
Friedell, H. L., 606
Friedman, Milton, 572
Fulton, John F., 777

Gagelmann, Franz, 619
Gallagher, D. M., 632
Galloway, T. C., 472
Gatch, W. D., 276
Gershon-Cohen, J., 456, 465
Geschickter, Charles F., 626
Gianturco, Cesare, 792
Gifford, Myrnie A., 628
Glasser, Otto, 538, 763
v. Godin, Frhr. K. L., 624
Goinard, Pierre, 160
Goltz, H. L., 122
Graham, A. Stephens, 453
Grier, George W., 864, 865
Gross, Arthur, 791
Grossman, J. W., 481
Gutman, Alexander B., 319

Haas, S. L., 677
Habein, H. C., 150
Hansen, G., 624
Harris, Louise M., 158
Hartung, Adolph, 481
Harvey, Roger A., 110
Hauert, D., 614
Hauser, Harry, 656
Hauser, I. Jerome, 146
Hawley, S. J., 760, 765
Heggie, James F., 629
Heiken, Charles A., 186
Henderson, W. R., 460
Henschke, U., 474
Henshaw, Paul S., 479
Henthorne, J. C., 150, 793
Hetzar, Walter, 633
Higinbotham, Norman L., 317

Hodes, Philip J., 393
Hodgen, John T., 795
Hodges, Frank C., 158
Hodges, Fred Jenner, 1, 82
Hodges, Fred M., 551, 864
Hodges, Paul C., 921
Hoffman, Samuel J., 154
Holmes, George W., 12, 37, 44, 56, 69, 74, 81
Holmes, L. P., 608
Horn, Henry, 154
Huber, H., 792
Hudson, Otho C., 607
Hunt, Howard B., 793

Ide, A. Gordon, 891
Iwasaki, H., 153

Jacobs, Lewis G., 478
Jaeger, W., 159
Jörg, Eduardo, 455
Johnson, Vincent C., 788
Johnston, Leland M., 148
Johnston, Robert A., 471
Jones, H. W., 632
Jones, J. William, 609
Jupe, M. H., 462
Juquelier, A., 778

Kaiser, R., 155
Kalbitzer, H., 624
Kalkbrenner, H., 478
Kalkstein, Mennasch, 153
Kaplan, Ira I., 138, 731
Kasabach, Haig H., 782
Katzen, Perry, 316
Keefer, Chester S., 619
Kelly, James F., 608
Kerley, Peter, 452
Keys, Ancel B., 606
Kienböck, R., 791
King, George C., 146
Kirklin, B. R., 811
Klaas, Rosalind, 634
Klassen, Karl P., 795
Klotz, Max O., 150
Knepper, Paul A., 314
Koenig, Edward C., 446
Koletsky, Simon, 615
Kommerell, Burkhard, 469, 470
Kornblum, Karl, 529
Kowaloff, Irving, 478
Kugel, M. A., 463
Kuttner, Ann G., 790

Lanari, Eduardo L., 455
Lander, F. P. L., 464
Lavine, R., 524
Law, John L., 157
Lawson, W. E., 285, 451
Leddy, Eugene T., 534, 555
Leedham-Green, J. C., 622
Le Gô, Pierre, 139
Lemke, H. H., 618
Leszler, Anton, 628
Lecutia, T., 866, 911
Levene, George, 60, 83
Levine, Samuel, 12, 37, 44, 57, 69, 74, 81, 411
Levitt, W., 630
Lévy, Max, 778
Lewin, Philip, 607
Liljestrand, G., 152
Lindgrin, Erik, 614
Lingley, J. R., 438
Löhr, W., 787
Loepp, W., 320, 787
Lofstrom, James E., 321, 330
Lowman, Robert M., 469
Ludwig, Herbert, 618, 619
Lynch, Kenneth M., 149
Lyons, Clinton G., 532
Lysholm, E., 152

McAneny, J. B., 609
McCullough, J. A. L., 534
McFarland, Joseph, 161
McGowan, John M., 314
McIntosh, Rustin, 621
Magendantz, Heinz, 316
Maksim, G., 793
Maresh, Marion M., 152
Martin, Hayes E., 298, 523
Martin, Joseph I., 376
Maseritz, I. H., 626
Mathes, Mary, 792
Matz, Philip B., 149
Medelman, J. P., 100
Meltzer, Adolph, 475, 756
Merritt, E. A., 418, 427
Meyer, Karl A., 154
Miller, J. M., 150
Miller, T. Grier, 632
Mills, John H., 620
Minton, Russell F., 503
Mohr, Werner, 792
Morey, John B., 789
Mottram, J. C., 480
Müller, Peter, 791
Müller, Walther, 624, 625
Muir, J. B. G., 460
Muller, J. H., 479

Nathanson, Ira T., 475, 477
Nichols, Bernard H., 608, 707
Noer, Rudolf J., 321
Norrish, R. E., 468
Nylin, G., 152

O'Brien, Frederick W., 403, 427
Oberholzer, J., 779
Obletz, Ben E., 625
Ochsner, H. C., 276
Oeser, Heinz, 626
Okrainetz, Clara L., 883
Olds, John W., 545
Olin, Harry A., 235

Palmer, Walter L., 630
Pansdorf, H., 156
Parsons, W. Barclay, 319
Pask, E. H. Allon, 471
Paterson, Ralston, 726, 820
Payne, Reginald T., 475
Peirce, Carleton B., 37, 607
Pendergrass, Eugene P., 329, 393, 663
Perham, W. S., 157
Perkins, Charles W., 341, 344
Person, E. Cooper, 159
Pessin, S. B., 148
Pfahler, George E., 549, 764, 902
Pfeifer, Walter, 465
Philipp, E., 792
Platou, Ralph V., 789
Pohl, John F., 623
Pohle, Ernst A., 148, 609
Pollitzer, Guido, 139
Pool, John, 609
Popken, Claus, 469
Popma, Alfred M., 793
Poppel, M. H., 721
Porcher, P., 778
Potts, Frank N., 625
Prevot, R., 155
Pyrah, Leslie N., 470

Quimby, Edith H., 609

Raap, Gerard, 607
Raban, John, 622
Raia, Antoinette, 616
Rankin, Fred W., 453
Reback, Samuel, 345
Reeves, Robert J., 339, 847
Reindell, H., 790
Reinhard, M. C., 122
Reischauer, F., 623
Renton, J. Mill, 629
Reuter, E. G., 847
Reyersbach, Gertrude, 790
Rhoads, J. E., 154
Richer, Ange, 217
Richet, Charles, 139
Richman, Samuel, 843
Rigler, Leo G., 606, 789
Ritvo, Max, 340
Robb, George P., 14, 450
Robertson, H. E., 627
Robin, N. H., 607

Robin, P. A., 607
Robins, S. A., 608
Roesler, Hugo, 72
Rosenblatt, Milton B., 147
Rosensohn, Meyer, 709
Rosh, Rieva, 572
Ross, W. L., 565
Rovner, Leopold, 609
Rubenfeld, Sidney, 561
Rüsken, W., 787
Rundle, Frank, 461

Sachs, Maurice D., 833
Sampson, D. A., 797
Sayago, Carlos, 888
Schlezinger, N. S., 192
Schmitt, H., 147
Schmitz, Henry, 402
Schomer, Alexander, 788
Schwartz, Charles Wadsworth, 367
Schwarz, Gabriel A., 345
Scott, Clifton R., 104
Scott, Roland B., 796
Seedorf, E. E., 811
Sereghy, Michael, 157
Shanks, S. Cochrane, 452

Shannon, E. H., 173
Shannon, W. Ray, 319
Shay, Harry, 456
Shiflett, E. L., 689
Shiga, T., 153
Shoemaker, Rosemary, 627
Silver, Harry B., 788
Simon, O., 621
Skinner, E. H., 292, 466
Smith, F. L., 2nd, 480
Smith, R. M., 632
Snead, L. O., 551
Snow, William, 142, 709, 718
Solis-Cohen, Leon, 411
Sontag, Lester W., 158, 319
Sosman, Merrill C., 47, 789, 797
Sotier, Adolf, 463
Spencer, Jack, 628
Spiegel, Milton B., 671
Spinzig, Edgar W., 246
Sprunt, Thomas P., 318
Stecher, William R., 264
Stehr, L., 474
Stein, Eleanor, 154
Steinberg, Israel, 14, 82, 450
Steiner, Matthew M., 316
Steiner, Paul E., 159
Stewart, H. L., 480
Stewart, William H., 330, 607
Stites, James R., 693
Strongin, Harry, 151
Stumpf, Pl., 618
Surmont, Jean, 139
Sussman, Marcy L., 75, 606
Sweany, H. C., 634

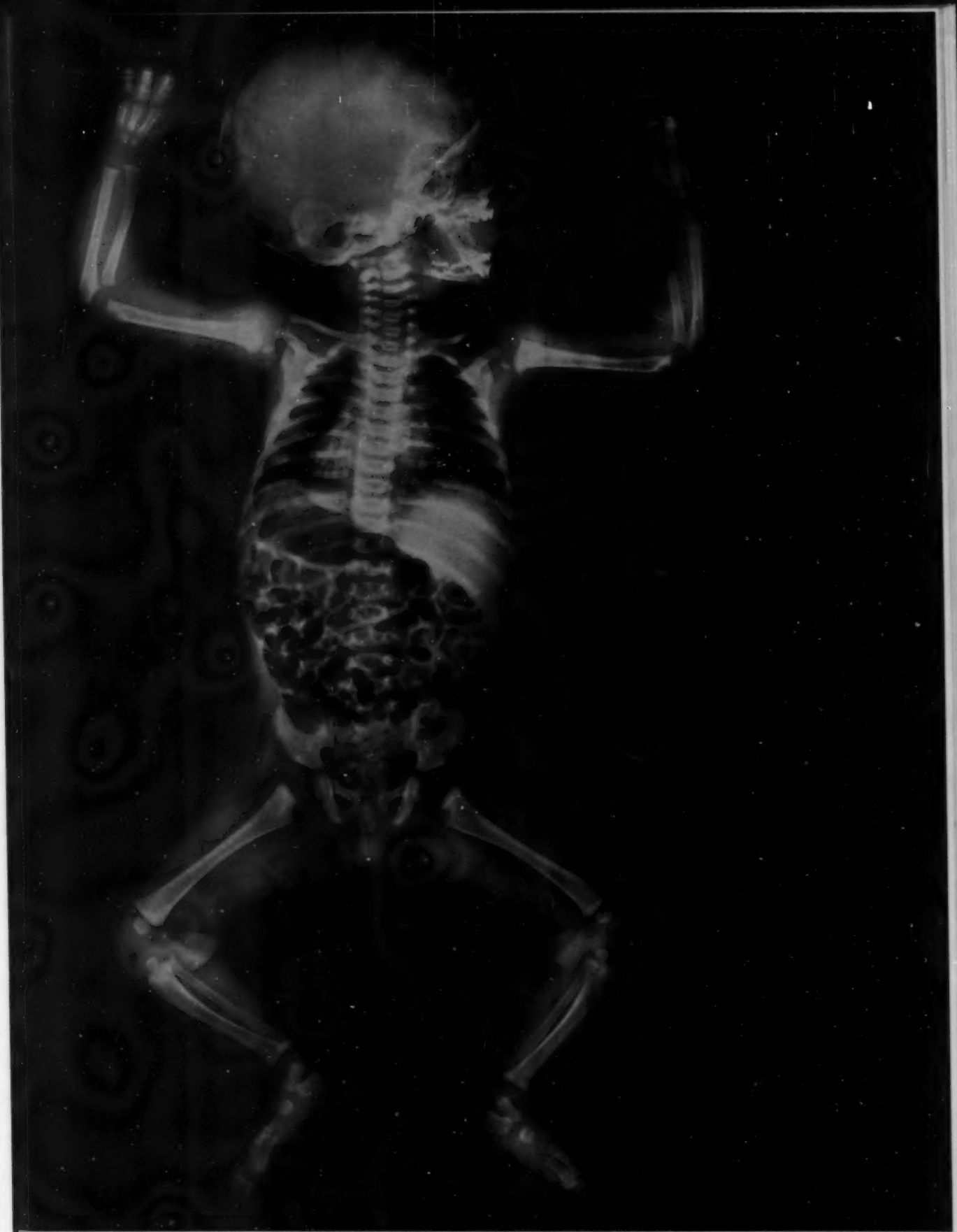
Taft, Robert B., 900
Tarlov, I. M., 471
Taylor, A. Brian, 466
Taylor, Grantley W., 475
Taylor, Henry K., 700, 707
Taylor, K. P. A., 795
Templeton, Frederic, 630
Terrill, E. H., 611
Thannhauser, S. J., 316
Thelander, H. E., 792
Tibbetts, Dorothy M., 632
Titche, L. L., 285, 451
Tocantins, L. M., 632
Tod, Margaret C., 726, 820
Torpin, Richard, 608
Turner, Philip, 622
Twining, E. W., 452

Ungar, Henry, 192

Veitch, A. H., 173
Von Dollinger da Graca, 890
Voshell, Allen F., 795

Wagoner, George, 663
Walters, Waltman, 314
Ward, Henry Baldwin, 454
Ward, R. Ogier, 471
Warren, Shields, 477, 628
Warren, Stafford L., 110, 891
Washburn, Alfred H., 152
Waters, Charles A., 138, 549, 857
Weinstein, M. L., 609
Weintraub, Solomon, 718
Welch, Claude E., 475, 477
Werblow, S. Charles, 617
Werner, H., 156
Wheeler, Digby, 468
Wichtl, Otto, 625
Widmann, Bernard P., 425
Wiese, E. Robert, 186
von Wieser, W., 934
Wilbur, Dwight L., 620
Willoughby, C. E., 480
Wintz, H., 935
Wirth, John E., 508
Wishart, D. E. S., 461
Wissing, Egon G., 469
Wolf, Alexander, 561
Wolman, Irving J., 789
Wolpers, Carlheinrich, 469
Woodard, Helen Q., 317
Wylie, J. R., 467

Zachrisson, C. G., 152



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EASTMAN ULTRA-SPEED SAFETY X-RAY FILM

(Technical Factors on Back of This Page)

Technical Factors for Radiograph Reproduced on Reverse Side of this Page....

REGION	**Entire body of infant**
AGE	**2 months**
WEIGHT	**10 lbs.**
HEIGHT	**24″**
POSTURE	**Supine**
PROJECTION	**Anteroposterior**
ANODE-FILM DISTANCE	**49″**
P-B DIAPHRAGM	**5-1 grid ratio**
TUBE FOCAL SPOT	**1.5 mm.**
PROTECTIVE FILTER	**.5 mm. aluminum**
FILM	**Eastman *Ultra-Speed***
SCREENS	**Eastman *High-Definition***
KV. P.	**85**
MA. S.	**15**
DEVELOPMENT	**Kodalk X-ray Developer (3½ min., 65° F.)**
FIXATION	**Eastman X-ray Fixer**

Eastman *Ultra-Speed* X-ray Film... Eastman *High-Definition* Intensifying Screens... Kodalk X-ray Developer Powders... Eastman Prepared X-ray Fixing Powders are made to complement each other. This combination in your laboratory will provide the best assurance you can buy of diagnostically excellent radiographs.

EASTMAN KODAK COMPANY

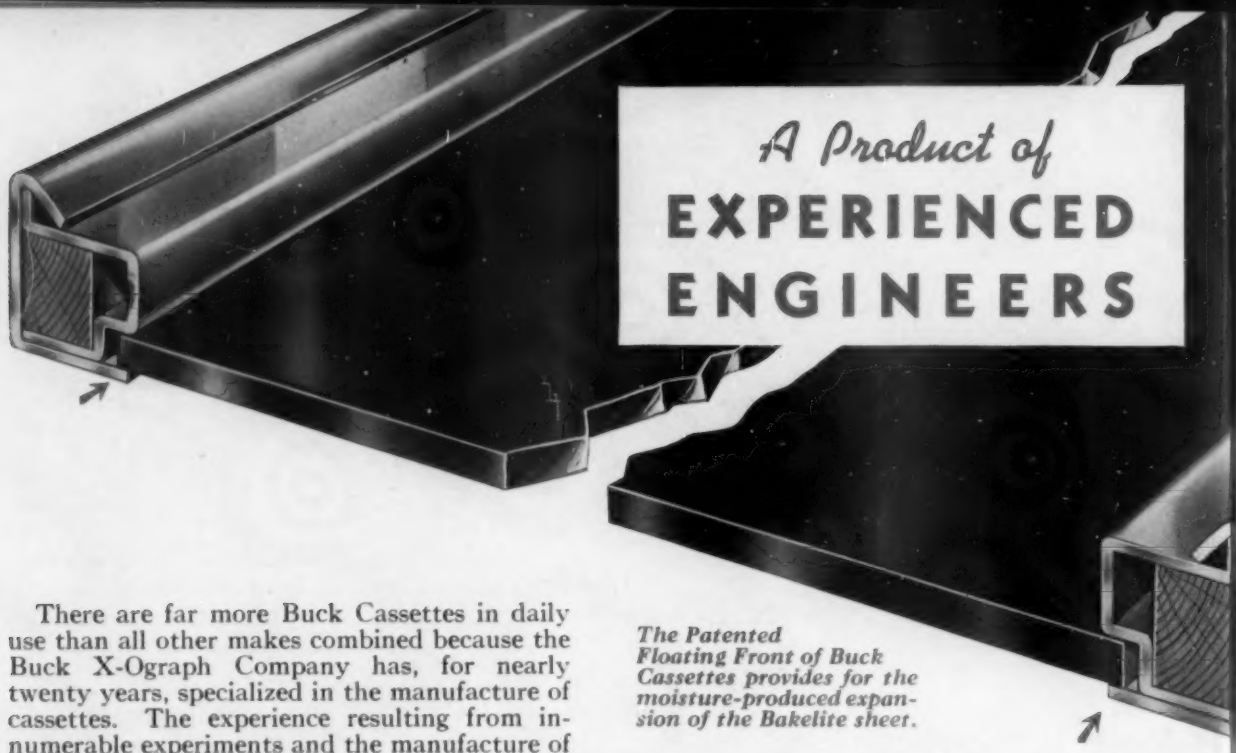
Medical Division—Rochester, N. Y.

(*See reverse side of this page*)

Know Your Cassette

STAINLESS STEEL
BUCK
MODEL

The Cassette of the Future will be of Stainless Steel



A Product of

EXPERIENCED ENGINEERS

The Patented Floating Front of Buck Cassettes provides for the moisture-produced expansion of the Bakelite sheet.

There are far more Buck Cassettes in daily use than all other makes combined because the Buck X-Ograph Company has, for nearly twenty years, specialized in the manufacture of cassettes. The experience resulting from innumerable experiments and the manufacture of many thousands of cassettes is summed up in the present-day *Stainless Steel Model* of Buck Cassette.

There are many requirements in the manufacture of a satisfactory cassette, but the most difficult problem of all is to build a cassette which will indefinitely retain its original screen-film contact and at the same time not damage the screens.

The inherent stress in an aluminum casting and its susceptibility to temperature changes, both of which tend to warp or buckle, caused us to perfect the *Die-Formed Hollow Frame* Cassette.

The specially woven felt and the embossed cover promote better and more lasting screen-film contact.

It is a well-known fact that greater strength and lighter weight is possible in a hollow type of construction, as compared with a solid type. If properly welded, the finished product possesses great strength in proportion to weight and, if correctly built, there can be no better type of construction for the purpose. But it is very important if the cassette frame requires plating, that the plating be applied to the four inside walls of the hollow frame as well as the exterior walls.

Although possessing great strength as compared to weight, the hollow type cassette frame has the disadvantage of denting the corners if accidently dropped. To correct this difficulty, all Buck Steel Frame and Stainless Steel Model Cassettes are reinforced by use of a kiln-dried hard wood shock-absorbing strip tightly fitted to the inside hollow of the frame. No other hollow frame cassette possesses this feature.

Due to the two-piece design of the frame, the shock-absorbing strip in Buck Cassettes can be placed in position before the frame is formed; this insures a perfect fit. If the cassette is dropped on a tile or concrete floor and lands on the corner, *the shock-absorbing strip absorbs the shock* by supporting the frame from within, thereby preventing serious damage to the cassette.

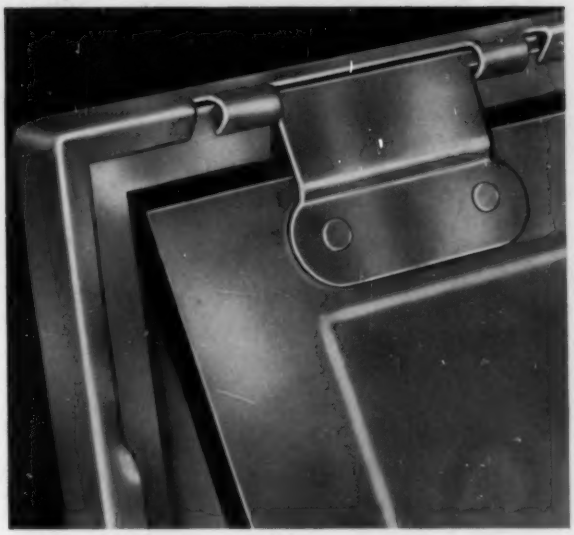
After making several thousand cassettes over a period of years we have never known of a single instance where the shock-absorbing strip has caused the cassette to warp out of alignment and any statement to the contrary is cheap sales propaganda.

It is far less expensive to make a cassette by omitting the shock-absorbing strip and welding together before plating, four pieces of metal tubing. This makes a fine-appearing cassette, but during the plating process acid is sure to get inside the tubing, where it cannot be completely removed and will eventually result in a cassette frame, the inside cavity of which is coated with rust. Particles of rust so formed will sooner or later find their way into the screens, where serious damage will take place.

The Buck Steel Frame Cassette is the only hollow frame cassette on the market which is plated on the internal surface of the frame. This necessary requirement is made possible by the two-piece design of the frame, which permits plating before forming. The design is covered by a U. S. Patent. The Stainless Steel Model does not require plating in any way.

In the manufacture of Buck Cassettes, the initial cost of dies for forming the specially designed frame into the various sizes of cassettes and the powerful presses required to do this work, mean an investment of many thousands of dollars but the improvement thereby obtained warrants the expense, as by use of the die-formed hollow frame it is possible to produce a cassette possessing absolute uniformity of size and alignment, a cassette which will not have a tendency to lose its original film-screen contact as the result of time, temperature, or use, nor will it damage the screens.

There are also other effects of the cassette on the screens, besides rust. If, in order to secure proper contact, the spring pressure is excessive or there are *irregularities in the smoothness of the cover or cover felt*, the life of the screens is sure to be reduced. The covers of practically all cassettes on the market, other than those of Buck manufacture, are equipped with pressed felt, a product made largely from short fiber material treated with a bonding agent and pressed to the required thickness. The distribution of material is rarely uniform, causing hard and soft spots with an overall lack of cushion which detracts rather than adds to film-screen contact.



The one-piece self-centering hinge insures a perfectly balanced fit of the cover to the frame.

You'll Know the Buck Cassette

BY THESE FEATURES

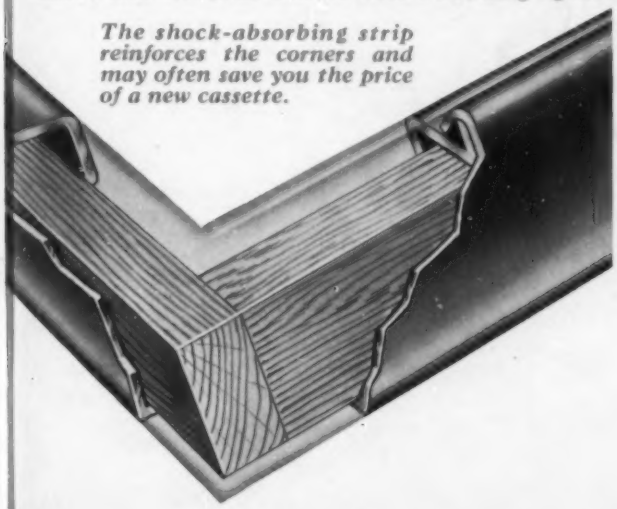
1. Die-formed Hollow Frame
2. Floating Front
3. Reinforced Corners
4. Embossed Cover
5. Self-centering Hinge
6. Woven Felt

For many years, Buck Cassettes have contained only the highest grade of long fiber, all-wool, *woven felt*. By weaving instead of pressing, it is possible to obtain uniform thickness and also avoid the use of a cement or bonding agent to hold the fiber together. By eliminating the bonding agent, the resiliency or cushion of the felt is greatly increased, all of which noticeably improves screen-film contact.

Woven felt of the required specifications is not a stock article and, therefore, must be manufactured to order. For this reason, it has been necessary to purchase a mill run quantity of several hundred pounds at a time, the price being far in excess of that paid for ordinary pressed felt—just another reason why Buck Cassettes are so generally satisfactory.

Besides the question of rust, felt, etc., having a noticeable effect on the screens, there is also to be considered, the type of cover hinge used.

All makes of cassettes, for many years past, have the fulcrum of the hinge located close to the outside of the cassette frame. This prevents grinding together the two surfaces of the screens when opening and closing the cassette, in addition to which it has been found necessary to use a hinge design which will permit floating of the cover in the frame. If the cassette cover is not free to move in all four directions, it is apt to fit the frame more closely on one edge than the other. If the fit is but slightly tight on one side



The shock-absorbing strip reinforces the corners and may often save you the price of a new cassette.

The Die-Formed Hollow Frame is composed of: Fig. No. 1—Inside section, Fig. No. 2—Shock-absorbing strip, Fig. No. 3—Outside section, Fig. No. 4—Sections One, Two and Three, die-formed and clinched into one piece to produce a Hollow Metal Frame of uniform size. Unless made of stainless steel, Sections One and Three are plated before being formed. This prevents rusting on the inside walls of the cassette frame.

or one end, it is sure to wear lint off the felt edge of the cover. This lint gets into the screens and mars the appearance of the finished radiograph. The wearing away of the felt may eventually cause the cassette to leak light.

Due to the special design of the hollow frame used on Buck Cassettes, it is easily possible to produce a strong but simple *one-piece self-centering hinge*, free from numerous small parts which may eventually break down from ordinary wear. This hinge permits the cassette cover to center itself in the frame like a cork in a bottle and lift with the fulcrum located at the extreme outer edge of the cassette frame—a feature found in no other hollow frame cassette on the market and is just another reason why so many Buck Cassettes are in daily use.

In conjunction with the felt and the hinges, there is also the cover itself which should present a perfectly flat plane to the screens and possess sufficient strength to retain this plane indefinitely. Just an ordinary flat sheet will not suffice, as it will sooner or later become warped and proper contact may not exist over the entire area of the film and screens.

To prevent a tendency toward warping, the cover on all Buck Cassettes *is embossed on the four edges*. The embossing is done by use of dies in a powerful press which forces the aluminum sheet to a uniform plane and at the same time forms the embossing which causes the sheet to take on and retain the desired alignment . . . A Buck feature covered by a U. S. Patent. A lead sheet is then applied to the under side and the cover may now be looked upon as satisfactory from a scientific or engineering standpoint . . . Just another reason why Buck Cassettes possess superior quality.

The ideal radiolucent material for a cassette front would be one which presents a flat surface, free from irregularities and contains no heavy particles—a sheet which remains flat under all conditions, is not easily scratched or dented, and does not have a retarding effect on the x-rays.

At present the nearest approach to these specifications is found in an aluminum or Bakelite sheet, both of which are in common use and each has its advantages and disadvantages.

In a hot and humid climate, we recommend the aluminum front cassette, as under such conditions Bakelite is very apt to take on sufficient moisture to cause objectionable warping, hence a lack of screen-film contact.

When not subjected to a hot, humid climate such as a tropical climate, Bakelite gives very little trouble from warping if mounted in the cassette frame in a manner which will *permit expansion* of the Bakelite sheet *without producing tension*, such as floating in a groove or recess. This feature is exclusive in all Buck hollow-frame Cassettes and is covered by a U. S. Patent—a further proof that many years of experience in the making of cassettes insures results that cannot be found in the product of a less experienced manufacturer.

The large laboratory will find the strong leather lift mounted on the cover much easier on the fingers than a metal ring which is apt to loosen with continued use and become a nuisance.

Recent developments in the fabrication of Stainless Steel, its greatly superior strength and its resistance to corrosion, has enabled us to make a further improvement in the building of cassettes, which is the use of Stainless Steel frame and hinges with nickel alloy springs and rivets. This new type cassette will be known as our Stainless Steel Model.

Due to the high price of Stainless Steel, this cassette is a little more expensive than our old style plated Steel Frame Cassette, but the strength is far greater, with no increase in weight, and there is no plating to wear through, peel off or possibly rust. We have found that chrome or nickel plate will not indefinitely withstand the effect of the acid absorbed by the technicians' hands which come in contact with both the acid fixer and the cassette.

The strength of Stainless Steel in proportion to weight is responsible for the wide use of this material in airplane construction of today—it is more dependable where human life is involved and the same is true of Stainless Steel Cassettes when produced by experienced engineers.

BUCK X-OGRAPH COMPANY, ST. LOUIS, MO., U. S. A.

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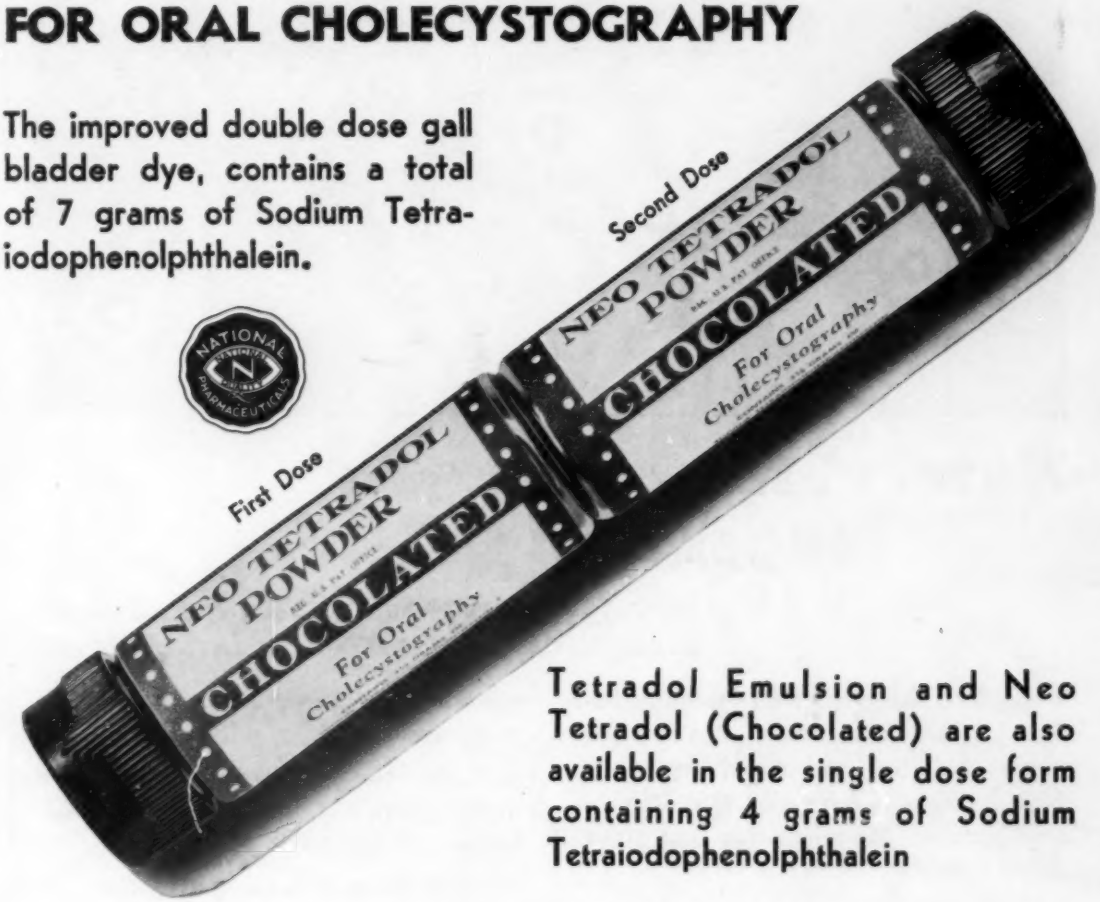

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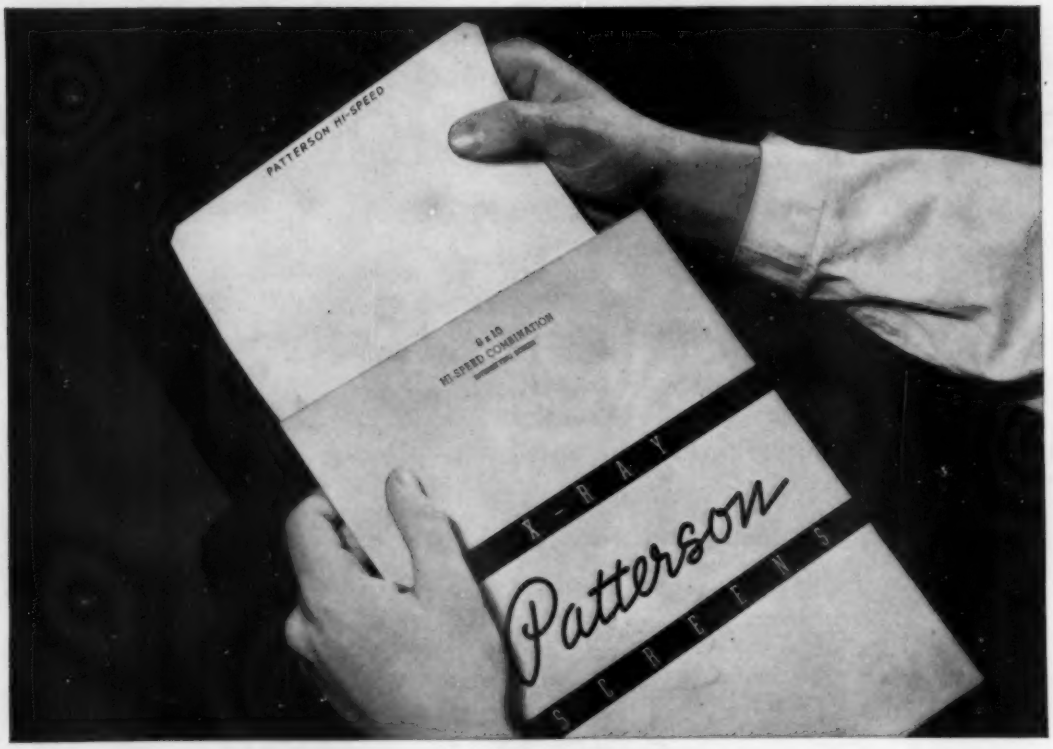

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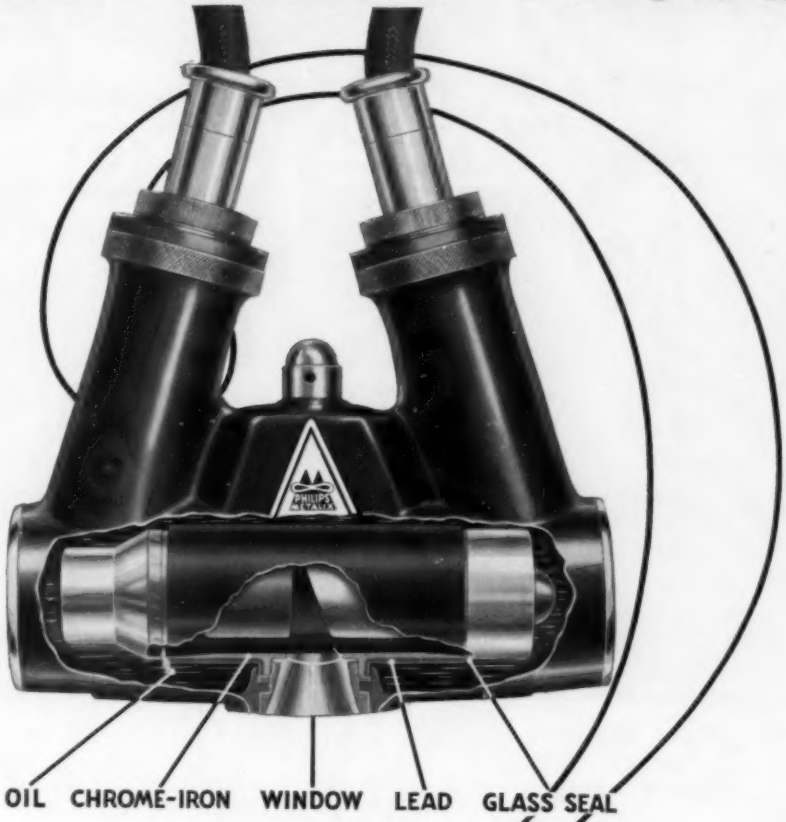

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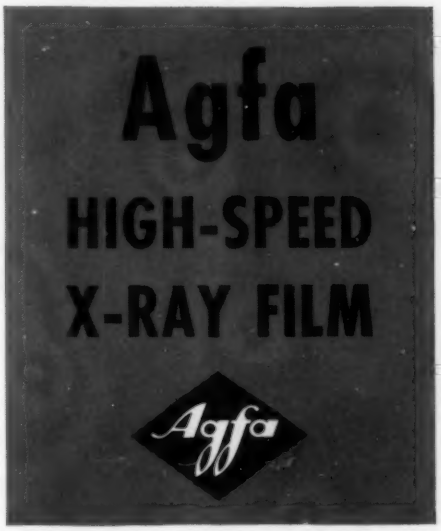

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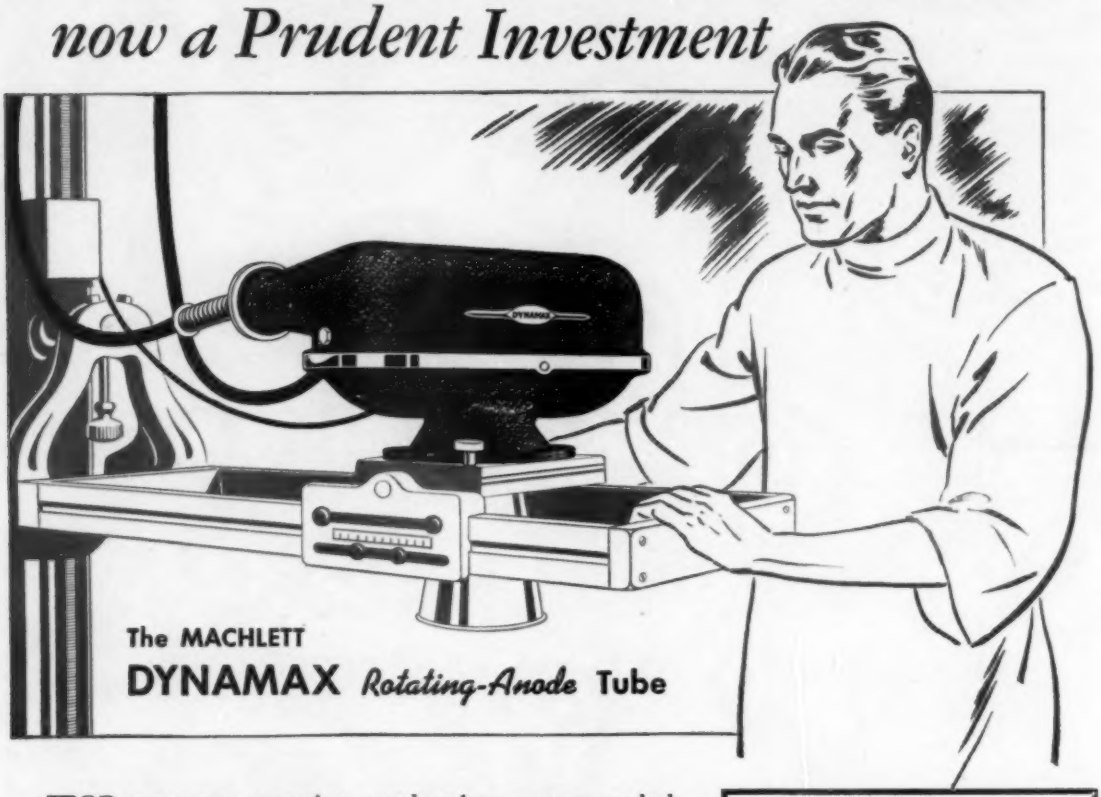

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Clinical Roentgen Therapy

Edited by ERNST A. POHLE, M.D., PH.D., F.A.C.R.
Professor of Radiology, Chairman, Department of Radiology and Physical Therapy, University of Wisconsin, Madison, Wisconsin

FOREWORD BY

GEORGE W. HOLMES, M.D.
Roentgenologist to the Massachusetts General Hospital and Clinical Professor of Roentgenology in Harvard Medical School, Boston, Mass.

Octavo, 819 pages, illustrated with 199 engravings and a colored plate
Cloth, $10.00, net. Published 1938

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THIS WORK represents the practical applications of the theoretical principles discussed in the author's companion volume, "Theoretical Principles of Roentgen Therapy." To it have contributed seventeen specialists of international reputation who, between them, cover every phase of the subject. They have produced the first comprehensive textbook on roentgen therapy in the English language and a thorough treatment of the entire subject, making it no longer necessary for the student to consult works in foreign languages. The book covers authoritatively all of the accumulated knowledge in this field and presents in detail the latest technique.

The need for such a book has become imperative with the increasing use of the roentgen rays as a therapeutic measure, particularly in the treatment of cancer. The separation of radiation therapy into roentgen and radium therapy has presented a difficult task. While the wisdom of such a sub-division has often been questioned, it must be acknowledged that it is impossible to present an adequate discussion of both in a single volume. However, in those cases which require the combined use of both roentgen-rays and radium, as in carcinoma of the cervix, sufficient data regarding radium therapy have been given to present a complete picture of the proper treatment.

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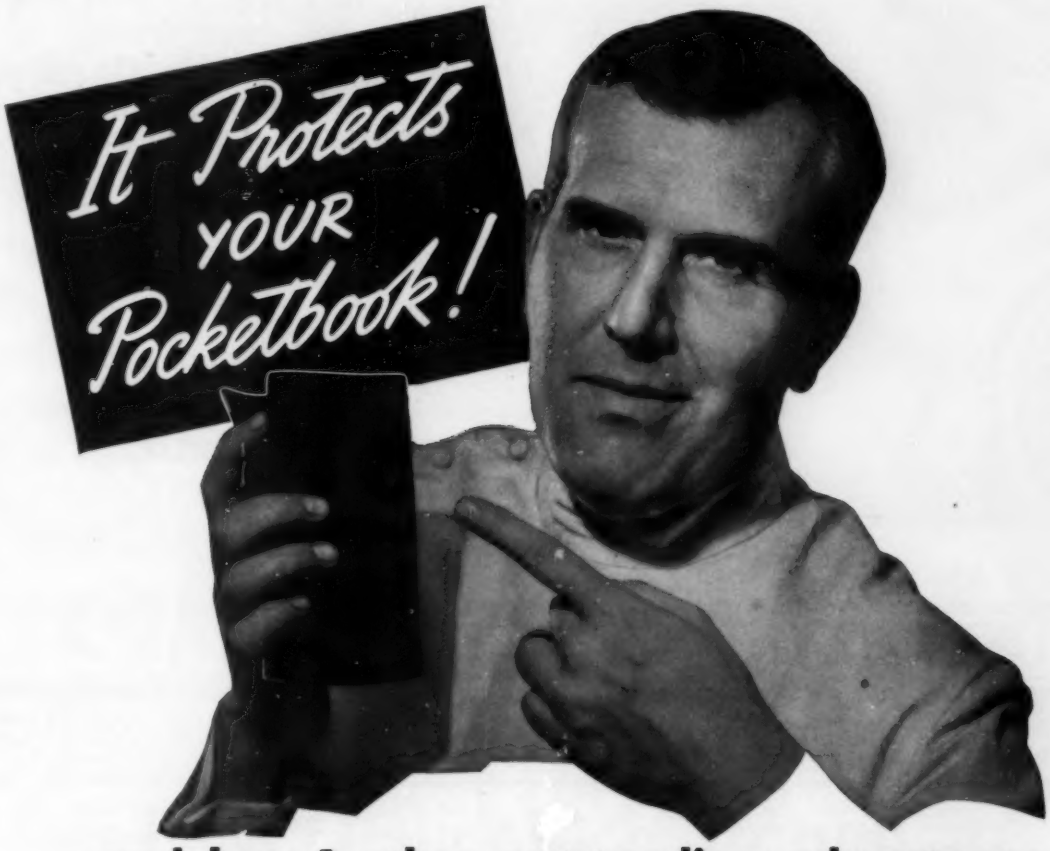

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INDEX TO ADVERTISERS

Agfa Ansco Corp. ix
Geo. W. Brady xiv
Buck X-Ograph ..... Insert before vii
Chalfonte-Haddon Hall xix
DuPont Film Mfg. Corp., Inc. ..... 2nd Cover
Eastman Kodak Co. ..... Opposite page 950
E. Fougera & Co. xvi
General Electric X-Ray Corp. ..... viii, xi
Gevaert Co. of America Inc. vi
Kelley-Koett Mfg. Co. ..... 3rd Cover
Lea & Febiger xii
J. B. Lippincott & Co. xv
Machlett Laboratories, Inc. x
Mager & Gougleman xvi
Mallinckrodt Chemical Works xvii
National Aniline & Chemical Co. i
H. B. Odmann xix
Patterson Screen Co. ..... ii, xiii
Philips Metalix Corp. v
Picker X-Ray Corp. ..... xviii, Back Cover
Standard X-Ray Co. xx
Jl. of Neurophysiology, CCT xix
Charles C Thomas xvi
University of Georgia xix
Victoreen Instrument Co. xiv
Westcott Paper xvi
Winthrop Chemical Co. vii

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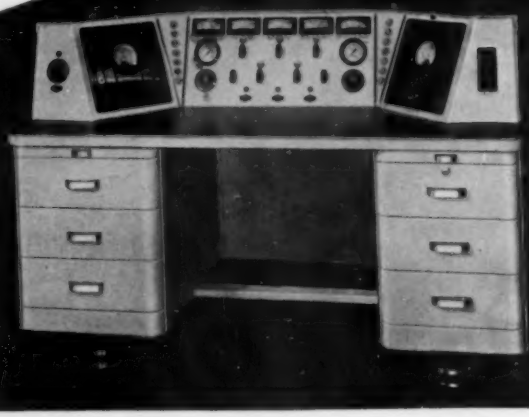

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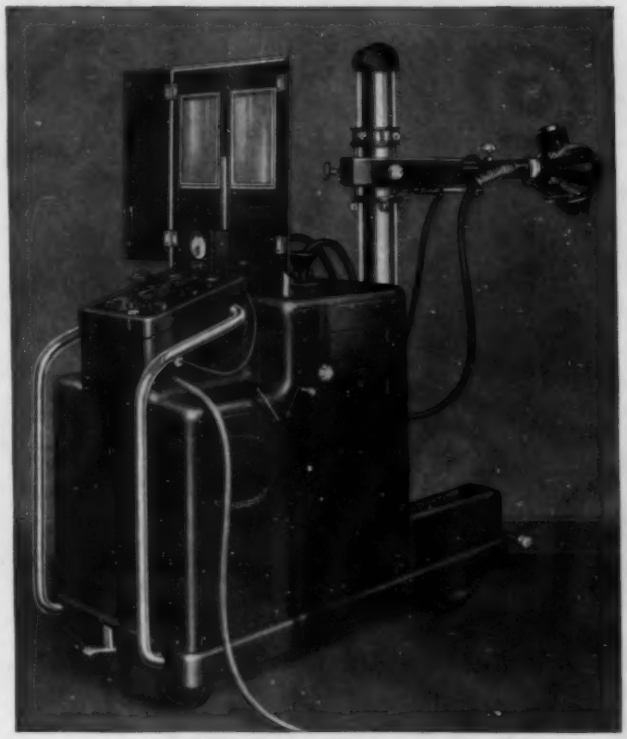

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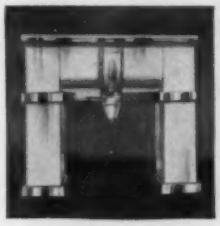

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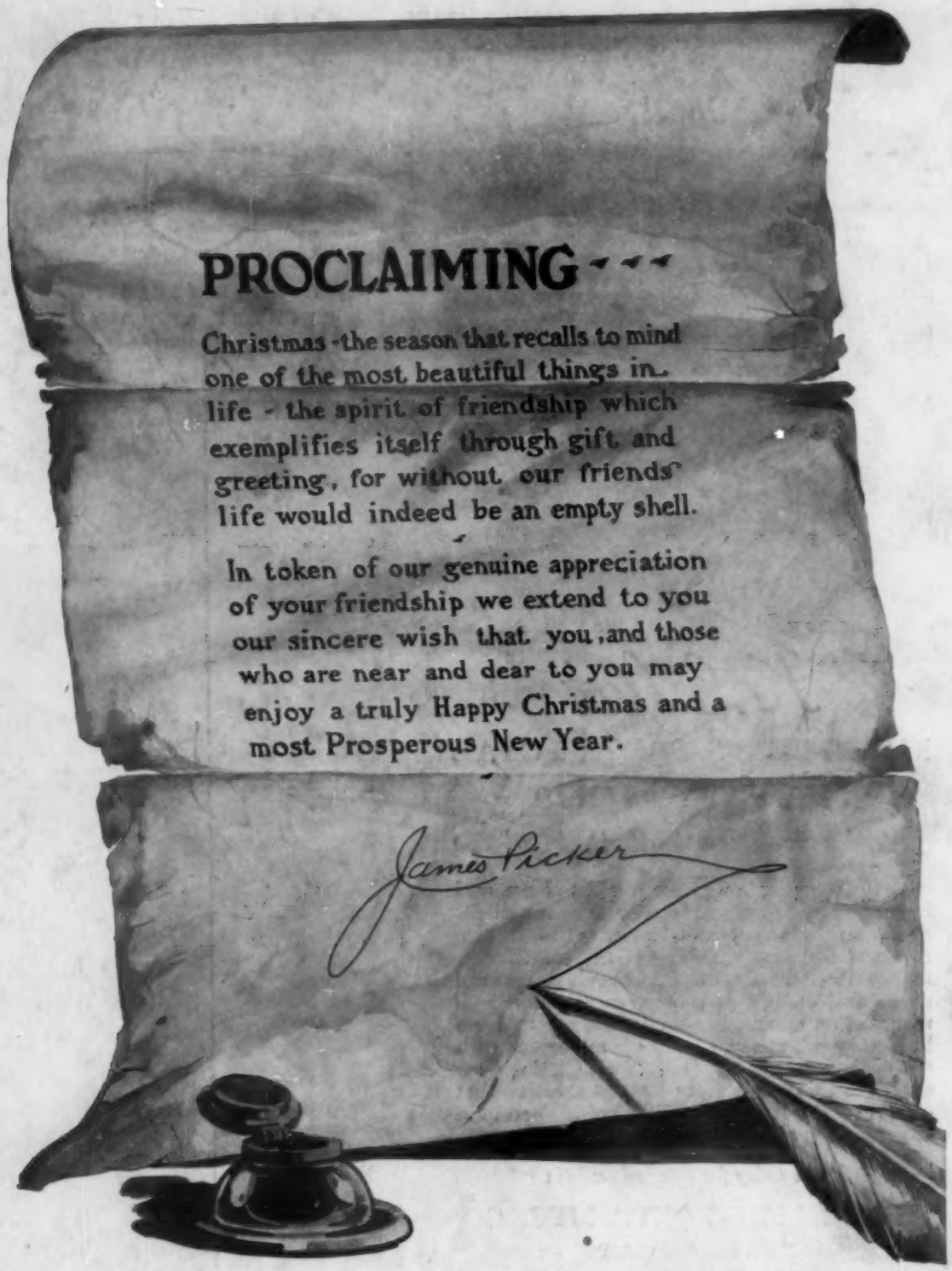
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